ENVIRONMENTAL ASSESSMENT OF FUEL JETTISONING AND DEVELOPMENT OF A GEOGRAPHICAL/ENVIRONMENTAL MODELING WITH GIS SOFTWARE

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LIST OF NOMENCLATURE

AESH	Association for Environmental Health and Science
AGL	Above Ground Level
ATC	Air Traffic Control
ATRCC	Air Traffic Radar
ATSDR	Air Route Traffic Control Center
AWACS	Airborne Warning and Control System
EIA	Environmental Impact Assessment
ESJ	External Jettison Site
FJSIM	Fuel Jettison Simulation
GIS	Geographic Information System
IFR	Instrument Flight Rules
JP-8	Jet Propulsion 8
MCL	Maximum Contamination Level
MSL	Mean Sea Level
PAH	Polycyclic Aromatic Hydrocarbons
TAFB	Tinker Air Force base
TRACON	Terminal Radar Approach Control
USAF	United States Air Force

Chapter 1

Introduction

1.1 Background

Jet fuel jettisoning is an active and intentional release of unused fuel from an aircraft in-flight. Due to in-flight emergencies or other unforeseen events, it occasionally becomes necessary for the United States Air Force (USAF) aircraft to discharge unburned fuel directly into the atmosphere while airborne. The primary reason for jettisoning fuel is to reduce the aircraft's gross weight to facilitate a safe landing.

A study by the USAF Engineering and Services Center of individual fuel jettisoning events reported by the USAF aircrews from January 1975 to June 1978 estimated that Air Force aircraft jettisoned fuel approximately 1000 times a year, totaling more than 16 million pounds per year (Clewell, 1980). Current fuel jettisoning data is not formally or centrally maintained. However, policy and procedures have been implemented to minimize the frequency of fuel jettisoning.

Fuel jettisoned by aircraft in-flight may pose an environmental hazard by reaching the surface and causing environmental contamination (Clewell, 1980). Jet fuel, when jettisoned from an aircraft, readily breaks up into small droplets and begins to evaporate. The fuel vapor and droplets are subject to entrainment in the aircraft wake, dispersion by atmospheric turbulence, and gravitational settling (Clewell, 1980).

From an environmental standpoint, the principal concern is what fraction of the fuel reaches the ground before it can evaporate and disperse. If liquid fuel reaches the ground, there is a potential for negative environmental consequences such as crop damage or water pollution (Clewell, 1981). Jet fuel jettisoned from planes can be transported via airborne dispersion, and some of it can be transformed photochemically to ozone and other components of smog (ATSDR, 1999).

Several studies made in the past have concluded that if JP-4, a highly volatile fuel which is readily evaporated and dispersed, was jettisoned above a critical altitude, the ultimate groundfall and related environmental impact would be negligible (Todd, 1995). However, as the Air Force moves to less volatile aviation fuels like JP-8, fuel jettisoning by the USAF aircraft poses a greater risk of ground contamination, because of its low volatility.

The low volatility of JP-8 jet fuel increases the time required for complete evaporation at ambient temperature (Todd, 1995). While these characteristics reduce operational evaporative losses, they also increase the chance that jettisoned fuel will affect and contaminate the earth's surface (Todd, 1995). Therefore, the USAF's conversion from JP-4 jet fuel to less volatile JP-8 jet fuel has significantly increased the likelihood of groundfall during fuel jettisoning events. Other United States and foreign military services are also converting to JP-8 jet fuels or similar fuels. Commercial aircraft use Jet fuel A, which is the commercial equivalent of JP-8 and behaves similar to JP-8 if jettisoned from commercial aircraft (Clewell, 1980).

The potential groundfall of jettisoned JP-8 jet fuel could significantly affect the operation of the USAF aircraft in the United States of America (USA). Environmental regulation and public pressure could restrict the range of flight operation available to the USAF aircraft if accurate characteristics of jettisoned JP-8 jet fuel are unknown (Todd, 1995). If the likelihood of jettisoned JP-8 jet fuel groundfall is determined to be high, then the Air Force needs tools to predict the impact of and to respond to these groundfall events.

1.2 Research Objectives

Tinker Air Force Base (TAFB) in Oklahoma City, Oklahoma, sponsored the research. The main objective of this project was to evaluate the potential environmental impact of fuel jettisoning events at Tinker Air Force Base (TAFB). The project addressed the impacts of jettisoning activities specific to aircraft type, weather patterns, and surrounding environmental compliance constraints. The Fuel Jettison Simulation (FJSIM) model developed by the USAF to estimate the impact of fuel jettisoning for different weapon systems under different operating scenarios was used. The detailed description of the FJSIM model and its input data are in Chapter 4. The meteorological data from Norman Station, Oklahoma, which include a representative wind profile, was used in the FJSIM model, which is discussed in Chapter 5 in detail.

The next objective of this project was to develop a system that can rapidly integrate the results of environmental models into a geographical information system. Hence, an interface with commercial Geographic Information System (GIS) software was developed. The output from the FJSIM model is used as input to a GIS subroutine. This integration provides decision makers with the ability to completely and rapidly analyze the impacts of any environmental release.

The primary limitation of this thesis is the lack of current data on jet fuel jettisoning. Many of our assumptions were made using previous survey data. The lack of current jettisoning data in the model forces us to accept the findings and assumption of previous work.

This report provides detailed information about how much fuel will contaminate the ground after a particular simulated jettisoning event in several weather conditions at TAFB with the help of the FJSIM model. This report also provides the predicted location of the plume in or outside Oklahoma after any simulated jettisoning event with the help of GIS.

Chapter 2

Literature Review

2.1 Weapons Systems and Jettison Capabilities

Many of the United States Air Force (USAF) aircraft have jettison capabilities. However, not all aircraft utilized by the USAF have the capability to jettison fuel. The most notable example is the B-52. TAFB has three notable aircraft that have jettisoning capabilities. Those aircraft are the KC-135, the E-3A and the B-1B. TAFB also has the B-52 aircraft. Since, the B-52 does not have jettison capability, it was not included for this study. Our study included three aircraft only, i.e., the KC-135 Stratotanker, E-3A Sentry and B-1B Lancer. KC-135 Stratotanker has a special characteristic of aerial refueling (USAF, 2001a). E-3A Sentry is an Airborne Warning and Control System (AWACS) aircraft that provides all-weather surveillance, command, control and communications needed by commanders of U.S. and North Atlantic Treaty Organization (NATO) air defense forces (AWACS, 1999). The Federation of American Scientists (FAS) has defined the B-1B as a multi-role, long-range bomber, capable of flying intercontinental missions without refueling, then penetrating present and predicted sophisticated enemy defenses (FAS, 1999b).

General specifications and characteristics of KC-135, E-3A and B-1B aircraft are shown in Figure 1, Figure 2 and Figure 3, respectively.

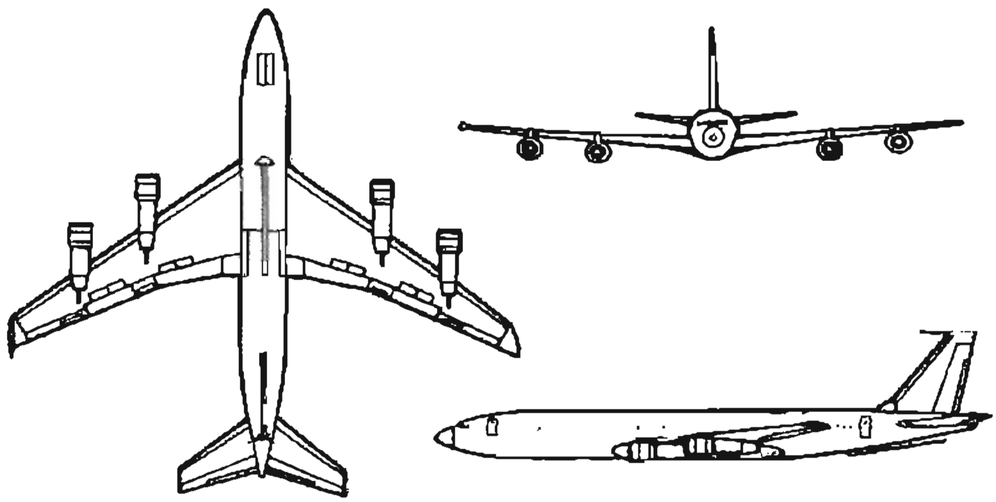


Figure 1: The KC-135 Stratotanker specifications

General characteristics of KC-135:

Length: 136 feet, 3 inches (41.53 meters)

Height: 41 feet, 8 inches (12.7 meters)

Maximum Takeoff Weight: 322,500 pounds

Maximum Transfer Fuel Load: 200,000 pounds

Maximum cargo capabilities: 83,000 pounds

Speed: 530 mph at 30,000 feet (9144 meters)

Jettison rate: 2951 L/min

Wingspan: 130 feet, 10 inches (41.53 meters)

Source: Diagrams from FAS (1995); Specifications from the USAF (2001a)

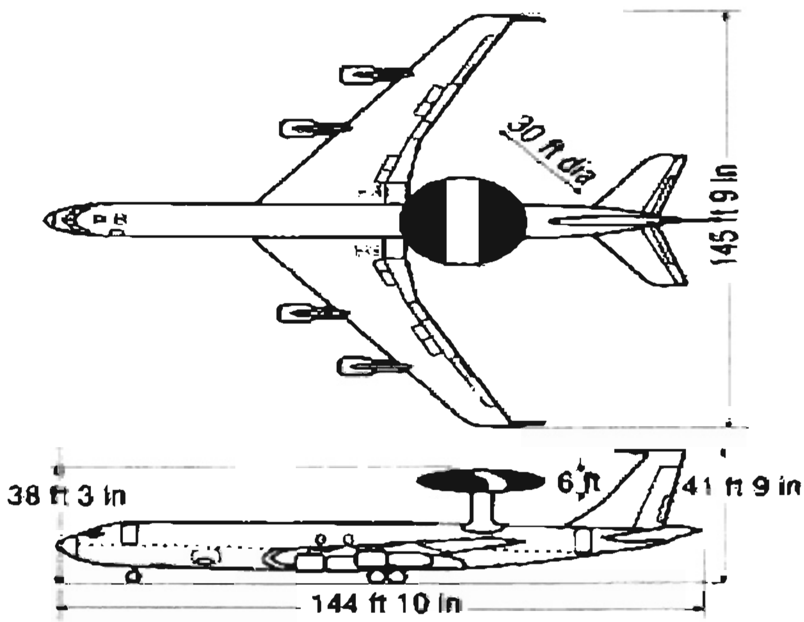


Figure 2: The E-3A AWACS specifications

General characteristics of E-3A:

Wingspan: 130 feet, 10 inches (39.7 meters)

Length: 144 feet, 10 inches (44 meters)

Height: 41 feet, 4 inches (12.5 meters)

Maximum Takeoff weight: 347,000 pounds

Gross weight: 335,000 pounds

Speed optimum cruise: 312 kts (360 mph)

Maximum speed: 460 kts

Jettison rate: 1634 L/min.

Source: Diagram from AWACS (1999); Specifications from Shill (2001)

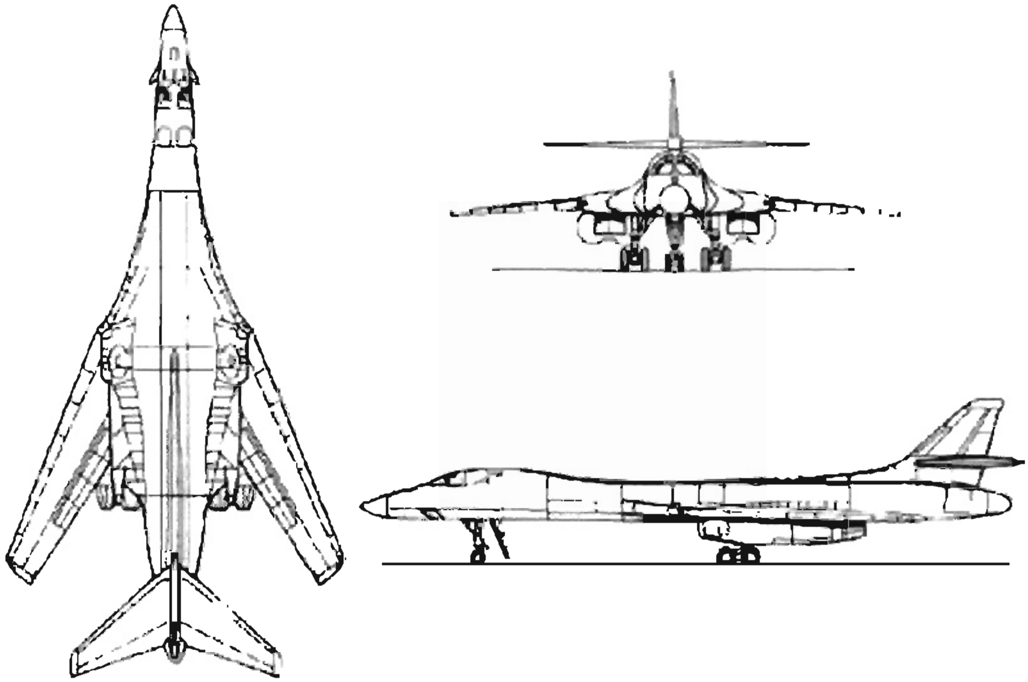


Figure 3: The B-1B Lancer specifications

General characteristics of B-1B Lancer:

Length: 146 feet

Height: 34 feet

Maximum Takeoff weight: 477,000 pounds

Empty weight: 150,000 pounds

Speed: 900-plus mph (Mach 1.2 at sea level)

Landing speed: 210 Gross - 145 kts

380 Gross - 195 kts

Jettison rate: 2724 L/min

Source: Diagram from Geocities (2002); Specifications from the USAF (2001b)

2.2 Jettison Reasons and Frequency

The term "fuel jettisoning" refers to the discharge of unburned fuel directly into the atmosphere by an airborne aircraft (Clewell, 1993). Fuel jettisoning usually occurs as the result of an in-flight emergency or unforeseen operational requirement. It is performed to reduce the aircraft's gross weight and facilitate a safe, expeditious landing. Most aircraft take off with a gross weight much higher than the maximum safe landing weight. If the aircraft must land prematurely due to an emergency or a change in operational plans, fuel is jettisoned to reduce weight to that recommended for safe landing (Clewell, 1993). In some cases, the nature of an emergency may lessen the airworthiness of the aircraft. In such cases, reducing weight even below the normal landing weight may be desired to permit a slower landing speed and improve control.

A report on fuel jettisoning prepared by Clewell (1980) for the Air Force addressed the frequency and causes of fuel jettisoning events during the period January 1, 1976, through June 30, 1978. His data showed that engine-related malfunction was the main reason for an emergency landing, requiring the jettisoning of fuel. Other causes included failure in hydraulic systems, fuel leaks, and medical emergencies. Some aircraft jettisoned fuel because of aborted missions that include radio or compass malfunctions as well as failure of a receiver aircraft to rendezvous with a tanker.

Clewell (1980) also reported that the USAF aircraft jettisoned fuel an average of 938 times a year, worldwide, during a period January 1, 1975, through June 30, 1978, totaling more than 16 million pounds per year. However, between 1975 and 1977, the amount of fuel jettisoning by the Air Force decreased by 18%. Current policy governing the conditions required to jettison fuel is much more restrictive than during the 70s. Most bases have pre-designated fuel jettisoning areas which are selected to minimize any impact, located so that prevailing winds will not carry fuel spray to urban areas, agricultural regions, or water supply sources.

2.3 Characteristics of Jet Propulsion-8 (JP-8)

As discussed before, the Air Force's conversion from JP-4 jet fuel to the less volatile JP-8 jet fuel has significantly increased the likelihood of groundfall during fuel jettisoning events. It is very important to know the characteristics of JP-8 and its environmental effects.

JP-8 is a jet fuel made by refining crude petroleum oil deposits found underground and under the ocean floor (ATSDR, 1998a). It is a complex mixture containing more than 200 aliphatic and aromatic hydrocarbons with 9 to 17 carbon atoms, including thousands of isomeric forms that distill at 170-325°C, and 3 to 6 non-hydrocarbon performance additives (BEST, 2003). The primary ingredient in JP-8 is kerosene, which is about 99.8% by weight (USEPA, 2002). JP-8 also contains individual components like n-alkanes, branched alkanes, benzene, alkyl benzenes, naphthalene, and polycyclic aromatic hydrocarbons (ATSDR, 1998a).

This fuel was developed as a jet fuel in response to problems encountered in the use of JP-4 jet fuel. One of the most important disadvantages of JP- 4 is its low freezing point (-58°C), which is ideal for cold climate flying only (ND, 2002). Some of these fuels were linked to aircraft exploding in battle when fuel tanks were hit by enemy fire. The primary reason the military changed to JP-8 was to help save the lives of pilots in combat. The USAF recognized that using kerosene-based fuel like JP-8 provides significant safety advantages because its lower volatility reduces the risks of in-flight/post crash fires and ground handling accidents (NAS, 2002). The fuel also acts as the primary heat sink to help cool the engine, therefore, the excess heat could cause the fuel to degrade, possibly fouling aircraft and engine components (ND, 2002). JP-8 has special fuel additives, known as +100 additives, which were developed to increase the thermal stability of JP-8 by 100°F (ND, 2002).

Clewell (1980) performed a study to determine the effect of fuel composition on the nature and extent of ground contamination by JP-4 and JP-8. The fraction of these fuels reaching the ground under various conditions was modeled. His results showed that fuel composition, as far as it determines the fuel's volatility and boiling range, has a significant effect on the extent of ground contamination by fuel jettisoned from aircraft. For JP-4, which has a highly volatile naphtha fraction, no appreciable ground contamination is likely to occur except for jettisoning very close to the ground or at extremely low ambient temperatures. This contrasts with JP-8 and Jet A, which have much less volatile kerosene fractions; they could reach the ground in larger quantities unless the ambient temperature is quite warm and the release altitude is well above the ground.

Clewell's study has concluded that the likelihood of significant quantities of liquid fuel reaching the ground is much higher for JP-8 than JP-4. Clewell mentioned that when the temperature at the ground is below freezing (0°C), more than 20 percent of jettisoned JP-8 reaches the ground before evaporating, regardless of the jettisoning altitudes. He also mentioned that several percent of the jettisoned fuel reach the ground in liquid droplets even for temperatures above 20°C.

The physical and chemical properties of JP-8 are given in Table 1

TABLE 1

PHYSICAL AND CHEMICAL CHARACTERISTICS OF JP-8

Fuel Type	JP-8
Composition maximums:	
Acidity, Total (mg KOH/g)	0.015
Aromatics (Vol %)	25.0
Sulfur, Mercaptan (wt %)	0.002
Sulfur, Total (wt %)	0.30
Volatility:	
Flash Point (°C) min	38
Density range (kg/l, 15°C)	0.755-0.840
Fluidity:	
Freezing Point (°C), maximum	-47
Boiling point (°C)	175-300
Viscosity @- 20°C, maximum	8.0 centistokes
Contaminant maximums:	
Existent Gum (mg/100 ml)	7.0
Particulate Matter (mg/l)	1.0
Additives:	
Icing Inhibitor (vol%)	0.10-0.15(F-35 opt.)
Antioxidant (mg/l)	17.2 min- 24.0 max
Metal Deactivator	5.8 max.
Static Dissipater	To within range
Other:	
Molecular weight	180
Heating value, Btu/lb, Minimum	18,400
Vapor pressure	0.029 psia @ 100°F
Vapor density (air=1)	4.5-5
Liquid density (water=1)	0.788-0.845 kg/L

Source: ATSDR, 1998b

2.4 Health Assessment of JP-8

Occupational exposure of military and civilian personnel to JP-8 may occur in several settings, such as transportation and storage of JP-8 fuel, aircraft fueling and defueling, maintenance of aircraft, cold engine starts and performance testing and fuel jettison events (BEST, 2003). Skin can be an important route of JP-8 exposures. Prolonged JP-8 skin contact can induce irritation, contact dermatitis, and sensitization (BEST, 2003). Because JP-8 is a complex mixture of hydrocarbons of widely varying vapor pressure and lipophilicity, uptake by the dermal route is highly affected by the physico chemical properties of the mixture. After dermal application to uncovered skin, individual volatile components may evaporate from the skin surface or penetrate the skin and pass into the venous blood for distribution throughout the body.

Inhalation of JP-8 vapors or aerosols results in respiratory tract deposition and systematic adsorption of some fuel components. Inhaled vapors, even those with high volatility and low water solubility, may be largely absorbed in the nasal cavity rather than in the lungs, although significant lung uptake may also occur (BEST, 2003). JP-8 is considered relatively nontoxic, except for heavy or repeated exposures. The Agency for Toxic Substances and Disease Registry (ATSDR) states that breathing in large amounts of JP-8 may result in headaches, difficulty in concentrating, coordination problems, fatigue and suffocation (ATSDR, 1999). Breathing lower amount of JP-8 for a longer period could result in sleep disturbances and dizziness (ATSDR, 1999). Repeated inhalation of JP-8 may result in activation of metabolic enzymes in the respiratory tract and, therefore, have an impact on the extent of production of both nontoxic and toxic metabolites (BEST, 2003). The Occupational Safety and Health Administration (OSHA) and Air Force Office of Safety and Health (AFOSH) have set an exposure limit of 400 mg of petroleum products per cubic meter of air for an 8-hour workday, 40-hour workweek (ATSDR, 1999).

No long-term studies of the chronic health effects, including cancer, of JP-8 exposure have been conducted. The International Agency for Research on Cancer has stated that there is not enough information to determine if jet fuels cause cancer (ATSDR, 1999). They also stated that at present, there is no evidence to suggest a link between jet fuel exposure and cancer in humans.

2.5 Environmental Assessment of JP-8

JP-8 is released into the air as vapors during fuel jettisoning. In addition, airborne jettisoning of fuels may result in contamination of surface water or groundwater and soils. If they make it to the surface, chemicals in JP-8 slowly move from the soil into groundwater. These chemicals may attach to particles in water and sink to the bottom sediments. In addition, bacteria and other organisms in soil and water might break down these chemicals (ATSDR, 1999). JP-8 may stay in soil for more than 10 years as components with higher boiling points persist longer in soil and water (ATSDR, 1999). The rate and extent of biodegradation are dependent on the ambient temperature, the presence of a sufficient number of microorganisms capable of metabolizing the component hydrocarbons, the amount of aromatic species in the jet fuels, and the concentration of jet fuel. It is possible that heavily contaminated soils or recovered liquids may be classified as hazardous wastes (Todd, 1995).

ATSDR (1998c) has determined that the transport and dispersion of JP-8 is dependent on the water solubility and volatility of the component hydrocarbon fractions. Lower molecular weight hydrocarbons such as n-alkanes may volatilize relatively quickly from both water and soil, while larger aliphatic may be sorbed to organic particles (ATSDR, 1998c). Aromatic hydrocarbons will be dissolved in the aqueous phase in both soil and water and may undergo some volatilization (ATSDR, 1998c).

There are no data concerning hydrocarbon contamination in soil due to fuel jettisoning in or around Tinker AFB. However, there have been the cases of soil contamination due to oil spillage or leakage in the soil in the area of Tinker AFB, which affected the nearby wells, rivers, ponds and groundwater (ATSDR, 1996).

2.6 Jettison regulations of TAFB

Current fuel jettisoning events are regulated by flying operations procedures for each aircraft. Fuel jettison is limited to the minimum necessary for safe and effective flight operation. Except in the case of an emergency, before jettisoning fuel, crews should notify the appropriate Air Traffic Control (ATC) or flight service facility of intensions, altitude and location.

According to TAFB regulations (OC-ALC-TAFB, Regulation 60-1), the aircraft commander is authorized to jettison fuel when an emergency requires a reduction of gross weight as a critical factor in the safe recovery of personnel/aircraft. If time/ aircraft capability permits, the aircraft commander will proceed to the TIK TACAN 142 radial and jettison between 17 and 32 Nautical Miles (NM). TIK is the identifier for the Tinker Air Force Base Airport. The Tactical Air Navigation (TACAN) system is a line-of-sight, beacon-type, air navigation aid that provides slant range; bearing and identification information to TACAN-equipped aircraft to determine the aircraft's position relative to the beacon (FAS, 1999c). Due to the hazardous nature of aviation fuels, fuel jettisoning should not be accomplished below 5,000 feet above ground level (AGL) and when possible above 20,000 feet AGL.

The aircraft commander will:

1. Advise Air Traffic Control (ATC) of the requirement to use the jettison area.

2. Request Oklahoma City Terminal Radar Approach Control (TRACON)/Fort Worth Air Route Traffic Control Center (ARTCC) issue radar vectors throughout the mission.

TRACON is usually located within the vicinity of an airport. Typically, TRACON controls aircraft approaching and departing between 5 to 50 miles of the airport. Radar equipment allows an air traffic controller to see the aircraft even at that distance (FAA, 1999).

ARTCC is a facility established to provide ATC service to aircraft operating on Instrument Flight Rules (IFR) flight plans within controlled airspace, principally during the en route phase of flight (FAA, 1999).

3. Designate jettison areas off published airways and avoid urban areas, agricultural regions, and water supply sources.

4. Avoid circling descents.

5. Use designated jettison areas to the maximum extent possible, except when safety of flight would be compromised.

6. Jettison fuel upon notification that the aircraft has entered the jettison area.

If jettison is accomplished, record all pertinent data to include:

1. Flight condition

2. Date and time of release

3. Altitude at which release occurred

4. Location of release

5. Type of amount of fuel

6. Aircraft type

7. Position at time of jettison

8. Time and duration of jettison activity

9. Brief description of emergency requiring release.

2.7 Detection levels and regulatory standards of hydrocarbons

The contaminants of concern from fuel jettisoning are benzene, toluene, ethyl benzene and xylenes, which are the most mobile and toxic of the total petroleum hydrocarbon family. Table 2 and Table 3 present the Oklahoma cleanup standards for hydrocarbon contaminated soil and groundwater respectively listed by Association for Environmental Health and Science (AESH),

TABLE 2:

OKLAHOMA CLEANUP STANDARDS FOR HYDROCARBON CONTAMINATED SOIL

Product	Parameter/ Constituent	Lab Test Protocol & Number*	Detection Level	Notification Level	Action Level	Cleanup Level
Gasoline, Diesel and Kerosene	TPH	EPA 8015	1mg/kg	Any amount above action level	>50mg/kg	Site specific RBCA standards
	Benzene	EPA 8020	1mg/kg	Any amount above action level	>0.5mg/kg	Site specific RBCA standards
	Toluene	EPA 8020	1mg/kg	Any amount above action level	>40mg/kg	Site specific RBCA standards
	Ethyl benzene	EPA 8020	1mg/kg	Any amount above action level	>15mg/kg	Site specific RBCA standards
	Xylenes	EPA 8020	1mg/kg	Any amount above action level	>200mg/kg	Site specific RBCA standards

Source: The Association for Environmental Health and Science (2002a)

Note: Oklahoma uses a Remediation Index in determining cleanup standards on a site-by-site basis.

* Whatever method is specified must be able to detect the most stringent cleanup levels. EPA Method 418.1 is not accepted testing method for TPH.

TABLE 3:

OKLAHOMA CLEANUP STANDARDS FOR HYDROCARBON CONTAMINATED GROUNDWATER

Product	Parameter/ Constituent	Lab Test Protocol & Number*	Detection Level	Notification Level	Action Level	Cleanup Level
Gasoline, Diesel and Kerosene	TPH	EPA 8015	1mg/L	Any amount above Action Level	> 2mg/L	Site specific RBCA standards
	Benzene	EPA 8015	1mg/L	Any amount above Action Level	> 0.005mg/L	Site specific RBCA standards
	Toluene	EPA 8015	1mg/L	Any amount above Action Level	> 1.0mg/L	Site specific RBCA standards
	Ethyl benzene	EPA 8015	1mg/L	Any amount above Action Level	> 0.7mg/L	Site specific RBCA standards
	Xylenes	EPA 8020	1mg/L	Any amount above Action Level	> 10.0mg/L	Site specific RBCA

Source: The Association for Environmental Health and Science (2002b)

Note: Oklahoma uses a Remediation Index in determining cleanup standards on a site-by-site basis.

* Whatever method is specified must be able to detect the most stringent cleanup levels. EPA Method 418.1 is not an accepted testing method for TPH.

Chapter 3

Environmental Setting

3.1 Surface features

Tinker Air Force Base (TAFB), activated in 1942, is located in Central Oklahoma, approximately 10 miles southeast of downtown Oklahoma City. It is an active industrial complex for overhauling, modifying, and repairing aircraft. TAFB maintains an External Stores Jettison (ESJ) site which allows pilots of aircrafts to drop external fuel tanks if they are experiencing grave emergencies. The present location of the Tinker AFB ESJ site is in an unpopulated section of the South Canadian River bed and floodplain approximately 10 miles southwest of Tinker AFB. Tinker AFB personnel have indicated that the ESJ site must meet the operational requirements of being located in the immediate vicinity of the base in an unpopulated area, with all-weather flight vectoring capability, be approximately 2.5 nautical miles (NM) long and one NM wide, and be readily visible from the air. The purpose of such an area is to allow pilots of aircraft experiencing grave emergencies to jettison external stores. It should be emphasized that if the ESJ Site is utilized due to an aircraft experiencing a grave emergency, no fuel will be jettisoned.

There is a separate site designated for "fuel jettison" at TAFB, addressed in OC-ALC-TAFBR 60-1. The jettison area is located from TIK TACAN 142 radial; aircraft may jettison between 17 and 32 NM from the TIK TACAN, according to aircraft flight manual procedures.

3.2 Climatology

Oklahoma's weather reflects the transitional nature of its geography. The climate in Oklahoma is Mediterranean to subtropical, characterized by hot summers and moist cold winters. Rainfall is uniformly distributed throughout the year, reaching a slight peak in spring in Central Oklahoma (Bourlier et al., 1987). Annual rainfall varies from more than 50 inches in the pine forests of the Ouachita Mountains of the southeast to less than 15 inches in the high plains of the western panhandle (OCS, 1982). Meteorological records obtained from the US Weather Bureau indicate that the average annual precipitation in Central Oklahoma Ranges from 33.19 inches to 34.14 inches (NOAA, 2000).

The east and southeast of Oklahoma are relatively humid, whereas western regions feature the warm days and cool nights. The average 6AM relative humidity is 75 to 85 percent throughout the year in Pottawatomie County, where the jettison area is located (Mayhugh, 1977).

The elevation in Oklahoma ranges from less than 300 feet above sea level in the extreme southeast to almost 5,000 feet on Black Mesa in the extreme western part of the panhandle (OCS, 1982). The mean elevation of the state of Oklahoma is 1,300 feet above sea level. The North Canadian River, the largest stream, flows across Oklahoma County (Johnson et al., 1995)

The average temperature of Oklahoma is 60°F. Outbreaks of cold air from the northern plains regularly send temperatures plunging, but the cold air usually is soon replaced by milder air returning from the south in winter (OCS, 1982). Warm, moist air spreads throughout Oklahoma during summer. Temperature can vary by as much as 50°F, either across the state on a single day or at a single location from one day to the next (OCG, 1982). High temperature commonly in the 90s and morning lows in the 60s and 70s are found in Oklahoma in the summer months. Monthly average temperatures range from a high of 93.9 degrees to a low of 24.8 degrees (NOAA, 2000). Snow is infrequent in Oklahoma. The prevailing wind direction is southerly in Oklahoma, but northerly and southerly winds occur with about equal frequency from December to March (Fisher et al., 1976). Average wind speed is 12 mph in summer and 15 mph in spring. Strong, gusty winds occur with thunderstorms and with low pressures systems from west to east during winter and spring (Mayhugh, 1977).

3.3 Soil Morphology

Six major soil groups occur in Oklahoma: Alfisols, Entisols, Inceptisols, Mollisols, Ultisols, Vertisols and stony-rocky land. Entisols occupy the least area. Vegetation in this region consists of short grass prairie and *Juniperus monosperma-Pinus edulis* woodlands. Alfisols and Mollisols are the most abundant soil groups in Oklahoma. Millisols are typically dark in color and associated with a variety of grassland vegetation types (Gray et al., 1976). Alfisols are light colored and sandy and range from deep to shallow sandy soils.

The soils on the uplands of Cleveland County formed in parent materials weathered sandstone, siltstone, shale, alluvial and colluvial mantle sediments, and eolian deposits. Eolian sediments and wind reworked alluvial sediments are common on the uplands paralleling the South Canadian River to the east and north. Alluvial sediments are extensive along the South Canadian River and Little River and the many tributaries throughout the area. The gently rolling soils on prairie uplands in the western part of the state formed in weathered sandstone and shale or in old alluvium. These soils are deep, dark colored, well drained and moderately permeable to very slowly permeable. In the valleys of the river and the larger creeks are silt and clay sediments that dropped from slowly moving or still water.

3.4 Geology

The surface geology of Central Oklahoma is composed primarily of sandstone formations, some areas of which have weathered into unique landforms harboring plant populations of biogeographic significance. Oklahoma has had a complex and varied geological history. Rock formation and deposits range in age from "most recent" through Precambrian. The oldest exposed rocks in Oklahoma are the Tishomingo Granite (1.35 billion years old) in the Arbuckle Mountains and the Spavinaw Granite (1.24 billion years old) in Mayes county, northeastern Oklahoma. These and similar rock types underlie most of Oklahoma (Gray et al., 1976). Pennsylvanian and older rocks occur beneath the Permian rocks, and some of the older rocks contain petroleum and natural gas of considerable economic importance (Wood et al., 1968). Lime accumulations occur at varying depths, depending upon the amount of soil moisture and evaporation to which they are subject. Sandy and loamy surface mantles of varying thickness are quite common, especially on the western portions along major streams (Gray et al., 1976).

3.5 Hydrology

The central Oklahoma aquifer system consists of geologic units of Permian and Quaternary ages that yield substantial volumes of water to wells from an extensive, continuous groundwater flow systems in central Oklahoma. The water may occur in unconsolidated deposits of silt, sand and gravel; in sandstone; in crevices and solution cavities in beds of limestone or gypsum; in fractures developed in shale and tightly cemented rocks; or in crevices formed in igneous and metamorphic rocks (Hart, 1996).

Surface water bodies in the Oklahoma City vicinity include the Cimarron, North Canadian, Canadian Deep Fork, and Little Rivers, and fabricated ponds and lakes. Some of the major streams are perennial, but flow normally stops for some periods each year in all the tributaries (Hart 1996). Groundwater in the Oklahoma City vicinity is derived from precipitation falling directly upon the area. Groundwater in this flow system originates as recharge from precipitation at a rate of about 40mm/year (Christensen et al, 1998). In some areas in Kingfisher, Canadian, Cleveland, Oklahoma and Pottawatomie counties, alluvium and terrace deposits are the source of water for irrigation, industrial and municipal use. As no large capacity wells are known to have been drilled in the alluvium and terrace deposits in the eastern half of the area, the potential yields of these units in this area are estimated based on geologic information (Hart, 1966). Most large capacity wells completed in the Central Oklahoma aquifer are from 30 to 250 meters deep and are completed in the Permian geologic units (Christensen et al., 1998).

The Permian geologic units consist of lenticular beds of fine-grained, cross-bedded sandstone interbedded with siltstone and mudstone. Most of the usable groundwater is in the Garber Sandstone and the Wellington Formation (Christensen et al., 1998). In Cleveland and Oklahoma counties, some wells are drilled 700 to 850 feet into the Garber-Wellington aquifer. In some areas of Seminole, Okfuskee, and Creek Counties, wells drilled 600 to 750 feet deep penetrate as much as 150 to 200 feet of saturated sandstone and commonly yield 100 to 150 gpm. In the eastern two-thirds of the outcrop area of the Vamoose Formation, drilled wells commonly yield 25 to 50 gpm. Domestic wells generally are less than 100 feet deep, and yields are small (Hart, 1966).

A National Water Quality Assessment (NAWQA) study in 1999 showed the median values for aquifer properties of Permian geologic units, which are as follows,

Transmissivity of the Garber sandstone and Wellington formation= 24 to 42 m^2/d

Horizontal hydraulic conductivity of sandstone= 1.4 m/d

Porosity of sandstone= 0.22

Storage coefficient= 0.0002

Recharge rate= 40mm/year.

3.6 Vegetation and wildlife

Major vegetation types in Oklahoma include tall grass prairie, short grass prairie, mesquite grassland and sand sage grassland. The United States Air Force (USAF, 1998) has included some of the other characteristic vegetation species within the project study areas in its "*External Stores Jettison Site*" report, which are as follows:

Flowers and grasses

Switchgrass (*Panicum virgatum*)

Big bluestem (*Andropogon gerardi*)

Little bluestem (*Schizachyrium scoparium*)

Indiangrass (*Sorghastrom nutans*)

Eastern gamagrass (*tripsacum dactyloides*)

Beaked panicum (*Panicum sp.*)

Canada wildrye (*Elymus canadensis*)

Scribner panicum (*Panicum sp.*)

Purpletop (*Tridens flavus*)

Sideoats grama (*Bouteloua gracilis*)

Maximilian sunflower (*Helianthus maximiliani*)

Lespedeza (*Lespedeza sp.*)

Dotted gayfeather (*Liafris punctata*)

Tall dropseed (*Sporobolus asper*)

Florida paspalum (*Paspalum floridanum*)

Prairie clover (*Dalea sp.*)

Trees

Eastern cottonwood (*Populus deltoids*)

American plum (*Prunus americana*)

Eastern redcedar (*Junipersus viginiana*)

Autumn olive (*Elaeagnus umbellate*)

Osage orange (*Maclura pomifera*)

Shortleaf pine (*Pinus echinata*)

American sycamore (*Platanus occidentalis*)

American elm (*Ulmus americana*)

Green ash (*Fraxinus pennsylvanica*)

Hackberry (*Celtris occidentalis*)

Wildlife taxa/species typically associated with the project study areas are summarized below:

Fish

Speckled chub (*Hybopsis aestivalis*)

Gizzard shad (*Dorosoma cepedianum*)

Flathead chub (*Hybopsis gracilis*)

Silver chub (*Hybopsis storeriana*)

Channel catfish (*Ictalurus punctatus*)

Red shiner (*Notropis lutrensis*)

Largemouth bass (*Micropterus salmoides*)

Shortnose gar (*Lepisosteus platostomus*)

Bullhead minnow (*pimephales vigilax*)

Freshwater drum (*Aplodinotus grunniens*)

Freshwater drum (*Aplodinotus grunniens*)

Sand shiner (*Notropis stramineus*)

Sunfishes (*Centrarchidae*)

Arkansas river shiner (*Notropis girardi*)

Emerald shiner (*Notropis atherinoides*)

River carpsucker (*carpiodes carpio*)

Black and yellow bullheads (*Ictalurus melas and Ictalurus natalis*)

Amphibians

Toad (*Bufo sp*)

Leopard frog (*Rana pipiens*)

Southern leopard frog (*Rana utricularia*)

Bullfrog (Rana *catesbeiana*)

Plains leopard frog (Rana *blairi*)

Cricket frog (Acris *crepitans*)

Salamander (*Typhlomolge spp.*)

Strecker's chorus frog (*Pseudacris streckeri*)

Reptiles

Snapping turtle (*Chelydra serpentina*)

Red-eared turtle (*Chrysemys scipta*)

Western chicken turtle (*Deirochelys miaria*)

Box turtle (*Terrapene Carolina*)

Midland smooth softshell (*Apalone proximus*)

Western hagnose snake (*Heterodon nasicus*)

Western ribbon snake (*Thamnophis proximus*)

Spiny softshell turtle (*Trionyx spinifer*)

Great plains rat snake (*Elaphe guttata emoryi*)

Brown snake (*Storeria dekayi*)

Northern water snake (*Nerodia sipedon*)

Rough green snake (*Opheodrys aestivus*)

Birds

American coot (*Fulica americana*)

Great egret (*Casmerodius albus*)

Snowy egret (*Egretta thula*)

Green heron (*Butorides virescens*)

Killdeer (*Charadrius vociferous*)

Mississippi kite (*Ictinia mississippiensis*)

Interior least tern (*Sterna antillarum*)

Red tailed hawk (*Buteo jamaicensis*)

Rock dove (*Columbia livia*)

Mourning dove (*Zenaida macroura*)

Night hawk (*Chordeiles minor*)

Common flicker (*Colaptes auratus*)

Belted kingfisher (*Alcyon*)

Downy woodpecker (*Picoides pubescens*)

Eastern king bird (*Tyrannus tyrannus*)

Eastern peewee (*Contopus virens*)

Bank swallow (*Riparia riparia*)

American crow (*Corvus brachryhnchos*)

Bob-white quail (*Colinus virginianus*)

Bluejay (*Cyanocitta cristata*)

Carolina chickadee (*Parus bicolor*)

Tufted titmouse (*Parus bicolor*)

Carolina wren (*Thryothorus ludovicianus*)

Brown thrasher (*Toxostoma rufum*)

Northern mockingbird (*Mimus polyglottos*)

American robin (*Turdus migratorius*)

Brown headed cowbird (*Molothrus ater*)

Common grackle (*Quiscalus quiscula*)

Boat tailed grackle (*Quiscalus major*)

Bobolink (*Dolichonyx oryivorus*)

Eastern meadowlard (*Sturnus vulgaris*)

Cardinal (*Cardinalis cardinalis*)

Swamp sparrow (*Melospiza Georgiana*)

Eastern turkey (*Meleagris gallopavo*)

Grasshopper sparrow (*Ammodramus savannarum*)

Mammals

Virginia opposum (*Didelphis virginiana*)

Woodchuck (*Marmota monax*)

Gray squirrel (*Sciurus carolinesis*)

Eastern fox squirrel (*Sciurus niger*)

Plains pocket gopher (*Geomys bursarius*)

Muskrat (*Ondatra zibethicus*)

Beaver (*Castor Canadensis*)

Blacktail jackrabbit (*Lepus californicus*)

Eastern cottontail (*Sylvilagus floridanus*)	Raccoon (*Procyn lator*)
Deer mouse (*Permyscys maniculatus*)	Coyote (*Canis latrans*)
Hispid cotton rat (*Sigmodon hispidus*)	Prairie vole (*Microtus ochrogaster*)

3.7 Special habitat sites

There are several preserve parks in Oklahoma that could potentially be impacted by a jettisoned plume of fuel. These preserves include (Crawford, 1999):

- Bald eagle preserve and least tern preserve in Tulsa County
- Canadian River Least Tern Preserve, Cleveland County,
- Cucumber Creek Nature Preserve, Le Flore County,
- Dripping Springs State Park, Okfuskee County
- McGee Creek State Natural Area, Atoka County
- Pontotoc Ridge preserve, Pontotoc County
- Redbud Valley, Tulsa County
- Sequoyah National Wildlife Refuge, Haskell and Muskogee Counties

The Canadian River Least Tern Preserve protects several nesting sites along a 16-mile-stretch of the Canadian River. Likewise, McGee Creek State Natural Area, Atoka County, contains a rare species of rapidly disappearing sand grass. Pontotoc Ridge preserve, Pontotoc County, has a variety of songbirds. Rare and unusual floras are found in Redbud Valley, Tulsa County, which include ferns and other cliff species, cactus, yucca, and smoke tree. In addition, wintering species such as bald eagles, white pelicans, yellowthroats, Harris's sparrows, and several raptors are found in Sequoyah National Wildlife Refuge, Haskell and Muskogee Counties. Although some of these habitat sites are not close to the jettison area, long and wide simulated plumes could occur on windy days which might spread above these sites.

3.8 Threatened, endangered, and candidate species

The U.S. Fish and Wildlife Service lists 18 species in Oklahoma as federally endangered or threatened. These species are listed in Table 4.

TABLE 4:

FEDERALLY-LISTED ENDANGERED AND THREATENED SPECIES IN OKLAHOMA

Endangered	**Threatened**
Bat, gray (*Myotis grisescens*)	Cavefish, Ozark (*Amblyopsis rosae*)
Bat, Indiana (*Myotis sodalis*)	Darter, leopard (*Percina pantherina*)
Bat, Ozark big-eared (*Corynorrhinus townsendii ingens*)	Eagle, bald (*Haliaeetus leucocepthalus*)
Beetle, American burying (*Nicrophorus americanus*)	Madtom, Neosho (*Noturus placidus*)
Crane, whooping (*Grus Americana*)	Plover, piping (*Charadrius melodus*)
Curlew, Eskimo (*Numenius borealis*)	Shiner, Arkansas River (*Notropis girardi*)
Falcon, American peregrine (*Falco peregrinus anatum*)	Western prairie fringed orchid (*Platanthera praeclara*)
Pocketbook, Ouachita rock (Wheeler's pearly mussel) (*Arkansia wheeleri*)	
Tern, Least (*Sterna antillarum*) (Also called Interior Least Tern)	
Vireo, black capped (*Vireo atricapillus*)	
Woodpecker, red-cockaded (*Picoides borealis*)	

Source: Crawford, 1999

Chapter 4

Fuel Jettison Simulation (FJSIM) Computer Model and Geographic Information System (GIS)

4.1 History of fuel jettisoning models

The dispersion and evaporation characteristics and effects of JP-4 and JP-8 jet fuels and other aircraft fuels have been studied and correlated with the acquisition and refinement of various dispersion and evaporation modeling techniques. Lowell, in 1950, was one of the first researchers to specifically address the impact of jettisoned jet fuel. He first developed free fall and evaporation equations for JP-4 jet fuel droplets in a quiet atmosphere. He simplified the composition of JP-4 jet fuel by using a 10-component model with specified physical and chemical properties (Todd, 1995). Clewell undertook a comprehensive effort to characterize the dispersion and evaporation of jettisoned JP-4 fuel from 1972 to 1980. Clewell, in 1980, used Lowell's work as a basis for further research to better understand the droplet formation and evaporation of JP-4 jet fuel jettisoned from aircraft in flight (Clewell, 1981). Clewell expanded Lowell's 10-component model to a 33-component model, which was more representative of JP-4 (Todd, 1995).

Ferrenberg, in 1993, developed the Fuel-Dumping Impact Assessment Model (FDAIM). He implemented a unique dispersion model. Instead of a standard dispersion model, Ferrenberg divides the flight profile of the aircraft into a series of straight line, constant altitudes and segments (Todd, 1995).

The Fuel Jettison Simulation Model (FJSIM) was developed by Continuum Dynamics, Incorporated (CDI) as part of an ongoing contract with Armstrong Laboratory's Environics Directorate. The FJSIM combines and implements mathematical models for Lagrangian aircraft wake effects, Gaussian line source dispersion, droplet evaporation and ground deposition to predict the fate of jettisoned JP-8 jet fuel (Teske et al., 2000). Because this model is being used as the primary research tool, a complete detailed description of it is presented here.

4.2 Introduction of the FJSIM Model

Previous work in fuel jettison modeling has dealt mostly with jettisoning of JP-4 jet fuel and its impact on the environment, including simplified preliminary analysis, in situ studies in the atmosphere, and measured and predicted ground contamination (Teske, 1996). These studies concluded that if JP-4 were jettisoned above a certain altitude, the ultimate groundfall would not be significant and the corresponding environmental impact was minimal.

Recently, however, JP-8 jet fuel has been replacing JP-4 jet fuel for the US Air Force aircraft. JP-8 (like commercial Jet A) exhibits significantly lower volatility than JP-4; it is therefore anticipated that a significant portion of JP-8 jettisoned from any elevation in the troposphere will reach the surface (Quackenbush et al., 1994)

The Fuel Jettison Simulation (FJSIM) model is a tool that helps assess the environmental and health impact of fuel jettisoning events by estimating the amount of fuel that will reach the ground from a specified incident. This model was developed with higher confidence in groundfall prediction allowing accurate assessment of environmental insult due to jettisoned fuel. It uses computer simulation to predict the evaporation of jet fuels jettisoned into the atmosphere. The model includes complete information on most of the current Air Force inventory of aircraft, to include fuel jettison port locations and geometry, fuel flow rates, and wake effects. A Lagrangian approach is used to track the behavior of each fuel port exit stream through the assumed flow field (modeling aircraft wake and atmospheric effects) by writing trajectory equations of motion and then solving them exactly from step to step (Teske et al., 2000).

The FJSIM model is an operational and user-friendly personal computer model (Windows® Based) to predict the fate of jettisoned fuel. The FJSIM builds on previous research in the area of aerial pesticide spray application. The United States Department of Agriculture (USDA) Forest Service selectively used aerial spray applications to control forest pests. The U.S.Army was interested in using spray applications for defensive applications as they wanted to understand the behavior of spray material from the time the spray was released from the aircraft until it was deposited or, in the case of spray drift, diffused to concentration/dosage levels that were environmentally insignificant (Quackenbush et al., 1994). Williamson and Threadgill, in 1974, proposed studying spray drift and spray droplet dynamics through mathematical modeling as an alternative to field tests. By using mathematical models, all variables could be controlled as opposed to the many uncontrollable variables in the field. The model developed by Williamson and Threadgill simulated the droplet motion and evaporation for a single isolated droplet. They concluded that their model accurately predicted the horizontal and vertical movement of the droplets as well as the droplet diameter (Todd, 1995).

The original AGDISP (AGricultural DISPersal) model for the USDA Forest Service is based on a Lagrangian approach to the solution of the equations of motion of the released materials and includes simplified models for the aircraft wake and ambient turbulence effects. The AGDISP model tracks the motion of a group of droplets released from specified nozzle locations and treats the group as a spray droplet cloud. The dispersion of the droplets is calculated as the spray droplet cloud descends toward the ground surface (Todd, 1995).

FSCBG (Forest Service, Cramer, Barry, and Grim) is a Gaussian line-source model that takes the near wake results to AGDISP, predicts the downwind dispersion, and includes evaporation, meteorology, canopy penetration, and ground and canopy deposition factors. FSCBG incorporates an analytical dispersion model for multiple line sources oriented in any wind direction, an evaporation model for volatile spray components, and a canopy penetration model for forest canopy interception. The FSCBG model requires input data on meteorology, aircraft characteristics, and nozzle specifications, spray material characteristics, canopy information, and flight path information and then performs calculations with respect to meteorology, evaporation, canopy characteristics, near-wake, and dispersion (Quackenbush et al., 1994).

The FJSIM retains a substantial portion of the near-wake AGDISP and the downwind dispersion FSCBG code. The principle modification was to replace the water-based evaporation model with a multicomponent evaporation model applicable to hydrocarbon fuels (Todd, 1995). While concluding the description of the FJSIM model, Quackenbush (1994) states, "Several analytical and computational tasks must be undertaken to enhance the capabilities of the model. These include implementation of time varying meteorology, verification of JP-8 component evaporation rate and Law's multicomponent model in this application, and determination of the most appropriate droplet distribution." The derivations of the Lagrangian Model, Gaussian Model and Evaporation model are shown in Appendix A.

The FJSIM always begins at the main input screen with the default input parameters, which comprise the "default" data. A section of the main screen contains a description of the fuel jettisoning aircraft, its name, pumps (for C-130 only), speed, altitude, and flight direction. It is extremely important to use actual atmospheric data when modeling a jettisoning event. As stressed in the Users Manual (Teske et al., 2000) on page 21, "changing the atmospheric conditions (the meteorological inputs) can dramatically change the predicted groundfall on the surface."

4.3 Data Entry and Units

Data are entered by clicking in the appropriate data entry box and modifying the information found there. Some of the main data entries are described below:

4.3.1 Surface Elevation

All altitudes in the FJSIM model are referenced to Mean Sea level (MSL).

4.3.2 Aircraft name

The following aircraft are included in the FJSIM model database: A-10, B-1B, B-2, B-52, C-130, C-141B, C-17, C-21A, C-5A, CV-22, E-3A, F-111, F-117A, F-15, F-22, H-1, H-53, H-60, Harrier, KC-10, KC-135, T-1A, T-3A, T-6A, T-37, T-38, T-43A, and

Tornado. A last entry in the Aircraft name field is 'user defined' which means that the information can be entered for an aircraft that is not in the list.

4.3.3 Fuel Name

The following fuel names are included in the FJSIM database: No Evaporation (nonvolatile fraction of 1.0), Water (the fuel will evaporate like water down to one percent of its original amount, assuming a relative humidity of 20 percent), JP-4, JP-8 and JP-4/JP-8 Mixtures, all with a nonvolatile fraction of 0.01.

4.3.4 Aircraft flight speed

It is the air speed of the aircraft when jettisoning fuel. The known port flow rate and the 'Fuel Amount' are used with the 'Aircraft Speed' to determine the length of the fuel trail. Aircraft Speed may be expressed in miles per hour, feet per second, knots true air speed, kilometers per hour or meters per second, with a lower limit of 100 kts and an upper limit of 1000 kts.

4.3.5 Aircraft Flight Direction

This model assumes a single straight flight path with no backtracking. Changing the entry box value or moving the sliding scale enters the flight direction. Dividing the jettisoned fuel amount by the jettison rate and multiplying by the aircraft speed computes the length of the fuel jettison event. If jettisoning were done in multiple paths, the user must first estimate the amount of fuel released in one path, run the model for this amount of jettisoned fuel, and then multiply the model predictions by the number of passes flown. Total amount of fuel reaching the surface should not be affected by route of flight with respect to wind direction and the presence of overlapping flight paths.

4.3.6 Meteorology

A meteorology table summarizes the height, temperature, barometric pressure, wind speed and wind direction as entered. The profiles of temperature, barometric pressure, wind speed and especially wind direction are extremely important, as they determine the level of evaporation and the speed and direction of movement of the jettisoned fuel toward the surface. The input values can greatly affect final deposition levels and footprint. The model accepts up to ten meteorology entries of altitude, temperature, pressure, wind speed and direction. There must be a height for every meteorological value, but no height requires all meteorological values to be present.

If "Use Standard Atmosphere" is checked, the FJSIM will scale the temperature and pressure, extrapolating the lowest values entered in the table, and above the highest values entered in the table, to conform to the Standard Atmosphere lapse rates at the lowest and highest heights in the table. If no values are entered for temperature or pressure, a standard temperature will be assumed throughout, where the temperature equals 15°C and pressure equals 1 bar at the surface.

Wind direction must be entered carefully in the meteorology table. Wind direction between adjacent heights is treated by linearly interpolating across the smaller angle increment, whether the wind direction moves clockwise or counterclockwise.

4.3.7 Preferences

'Preferences' personalize the use of the program by preselecting its operation pattern, including whether to "Pause" before calculating, show the "Data Right Notice" at startup, set default units for all data entries into the model, override previous units with these units in the future, and set the deposition unit to ml/m^2 or mg/m^2, the total amount unit, and area unit for Area Coverage. Preferences apply to new input sessions or subsequent calculation performed to the FJSIM. The Preferences screen is shown below in Figure 4.

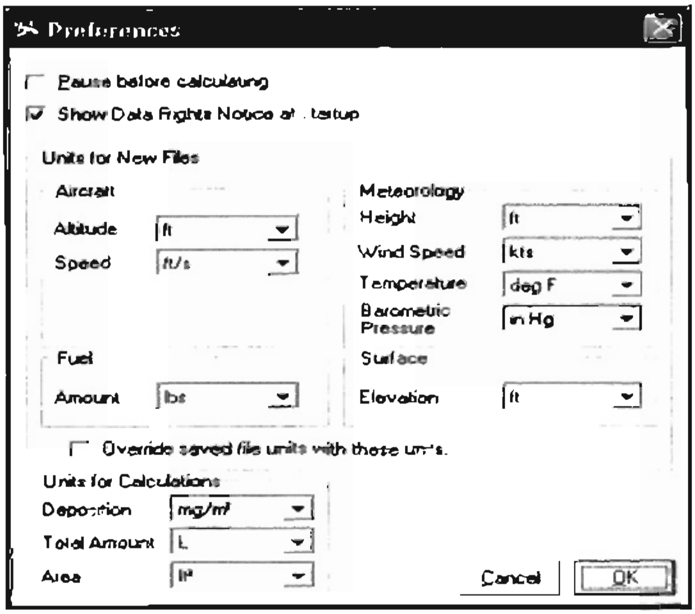


Figure 4: Preferences Input Screen

4.3.8 Calculations

Calculation can be done as long as the input values into the FJSIM model fall within the bounds specified in Table 5. Calculation Status is shown by a moving bar near the bottom of the screen, displaying the droplet size category being processed and the percentage of the number of droplet size categories completed.

4.4 Default values and model limits

The FJSIM model has default values for all data entry boxes and accepts a finite range of values for most input parameters. Many of the default values are not reasonable for Tinker AFB and should not be used. No default values were used in the performance of this project. Table 5 shows the FJSIM default inputs, lower limit and upper limit of the variables in the FJSIM model.

TABLE 5:

FJSIM DEFAULT INPUTS

Variable name	Lower Limit	Default Value	Upper Limit
Surface elevation (ft)	-300	0	15000
Aircraft:			
Aircraft altitude above sea level (ft)	30	1200	60000
Aircraft flight direction (to degree North)	0	90	360
Aircraft Name		McDonnell Douglas F-15	
Aircraft Flight Speed (kts)	10	173.8	1000
Fuel:			
Fuel amount	1	672.84	600000
Fuel name		JP-8	
Meteorology:			
Barometric pressure (in Hg)	3.0	29.53	60
Height (ft)	-300	6	60000
Temperature (deg F)	-40	70	120
Wind speed (kts)	2.0	2.61	260
Wind direction (From deg N)	0	45	360

Source: The FJSIM Manual, 2000

A larger problem is the range of accepted values. Some parameters have an actualránge larger than that accepted by the model. Most notable is temperature. The model can accept no temperature below -40°C. Temperatures below this value are routinely encountered at jettisoning altitude in Oklahoma during the winter. Another unrealistic default value is wind. The minimum wind speed accepted is 2.0 kts; calm winds less than 2 knots are encountered in Oklahoma at a certain altitude as shown in meteorological data from Norman Station on July 9, 2001, Table 1, Appendix B. The wind speeds at 2417 m and 2438 m were less than 2 knots on this day.

4.5 Products of the FJSIM model.

The primary product of the FJSIM model is a coarse graphical depiction of the predicted aerial extent of the groundfall of jettisoned fuel and contours indicating the deposition of fuel in that area (Teske et al., 2000). The model also estimates the surface area covered and the total mass and volume of fuel that reached the ground. The model can produce other output products, including a surface evaporation algorithm that can estimate how long it will take the fuel to evaporate from the ground. There are various plots in the FJSIM model, as described in the FJSIM manual (Teske et al., 2000), that produce these outputs. These plots are described below:

4.5.1 Cumulative volume fraction

It is a cumulative droplet size distribution plot, as shown in Figure 5, which compares the changes in volume fraction between the fuel immediately after jettisoning and the fuel that hits the surface

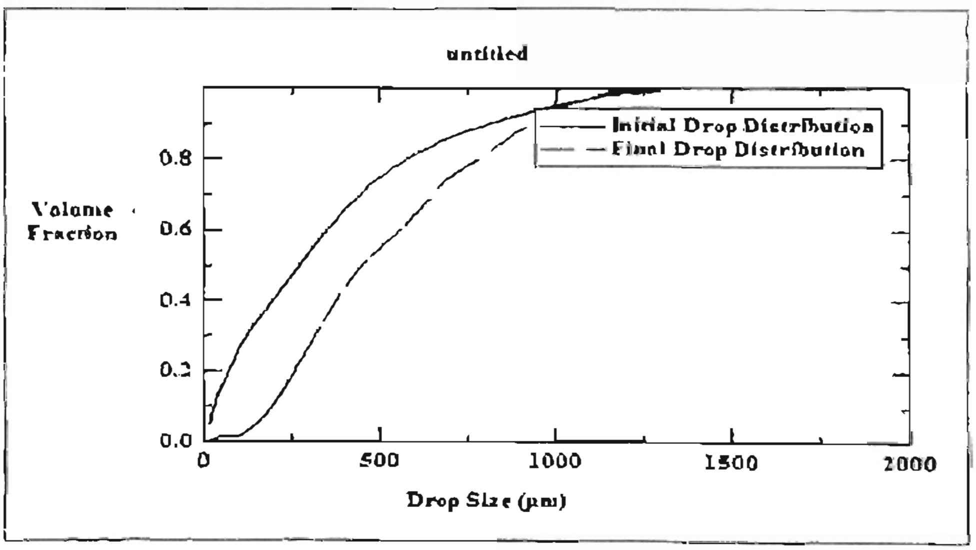


Figure 5: Example plot for cumulative volume fraction

4.5.2 *Isopleth deposition plot*

This plot, shown in Figure 6, predicts the aerial extent of surface coverage from the fuel-jettisoning event. The plot axis dimensions vary with the size of the modeled ground-level plume. The 0.0-point on the graph is the beginning of the jettison run. The solid black arrow indicate flight path. Default contour level reflects ½, 1/20th and 1/200th the maximum deposition as shown in the lower right in Figure 6.

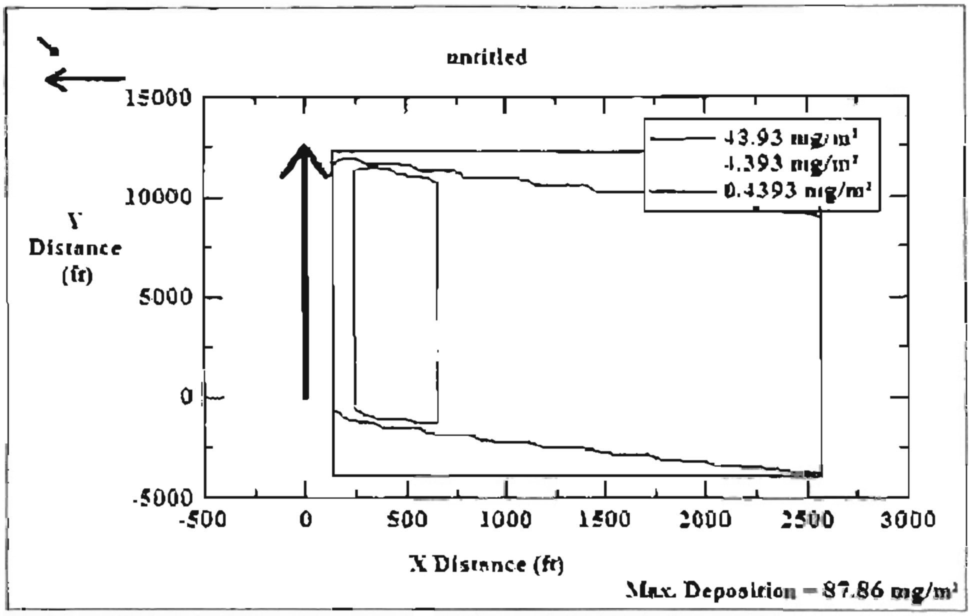


Figure 6: Example plot for isopleth deposition

Negative axial distance is behind the pilot; negative normal distance is to the pilot's left. The plot must be examined with care: not only does the area covered by the plot vary with the jettison event being modeled; the 0-0 point is almost never at the lower left edge of the plot. Since plumes can be dispersed behind and to the left of the pilot, the plots usually have considerable negative x and y value coverage.

4.5.3 *Deposition cross section*

The plot, shown in Figure 7, is viewed as if the user is looking along the flight path, with the aircraft flying into the page. This plot shows a cross-section of the surface deposition pattern normal to the path of the fuel jettisoning aircraft as if the fuel jettison trail were infinitely long.

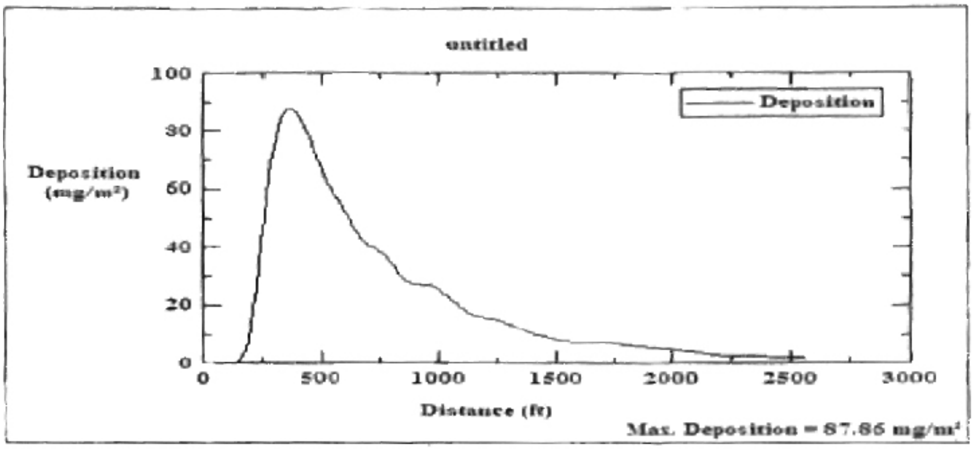


Figure 7: Example plot for deposition cross section

4.5.4 Fraction aloft height history plot

The plot, shown in Figure 8, is the fractional amount of jettisoned fuel aloft (not yet evaporated or deposited) as a function of height above the ground.

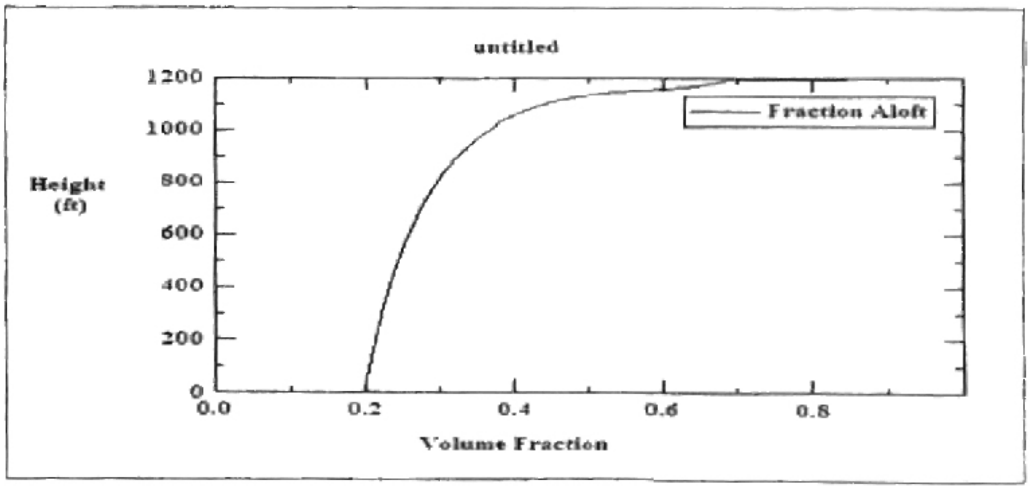


Figure 8: Example plot for fraction aloft height history plot

4.5.5 Fraction aloft time history plot

The plot, as shown in Figure 9, shows the accumulation in time of material on the surface. By subtraction, it also shows the percentage of total volume of jettisoned fuel that evaporates before the first droplets hit the surface.

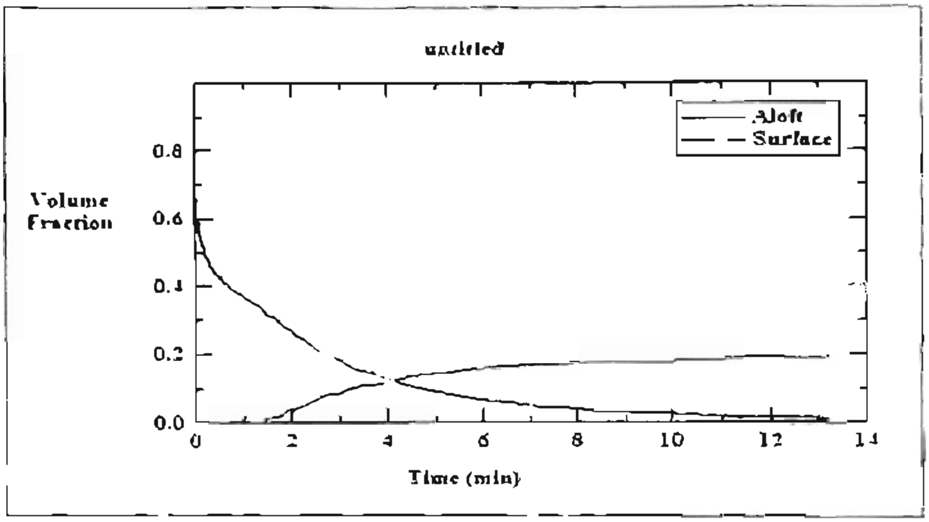


Figure 9: Example plot for fraction aloft time history plot

4.5.6 Vapor aloft height history plot

The plot, as shown in Figure 10, is the fractional amount of jettisoned fuel vaporized aloft (evaporated) as a cumulative function of height above the ground.

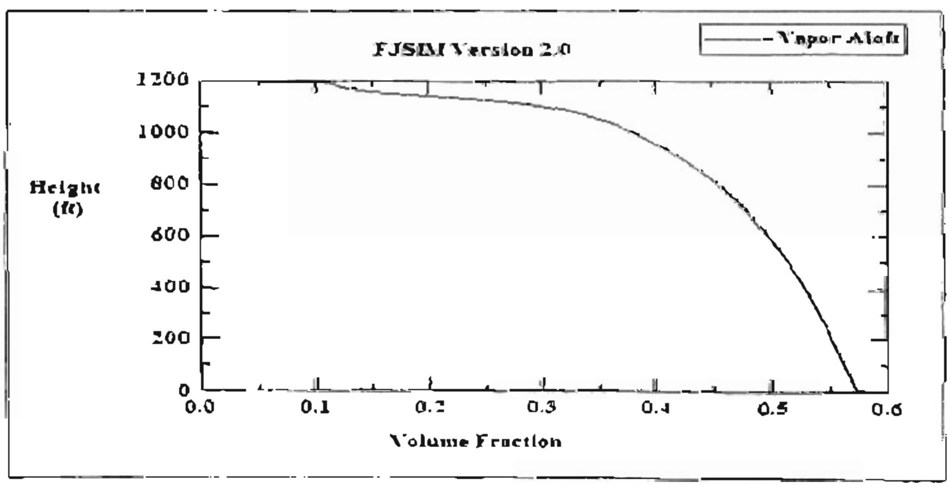


Figure 10: Example plot for vapor aloft height history plot

4.5.7 *Vapor aloft time history plot*

Cumulative vapor aloft time history plot, as shown in Figure 11, shows the distribution of evaporated material as a function of time.

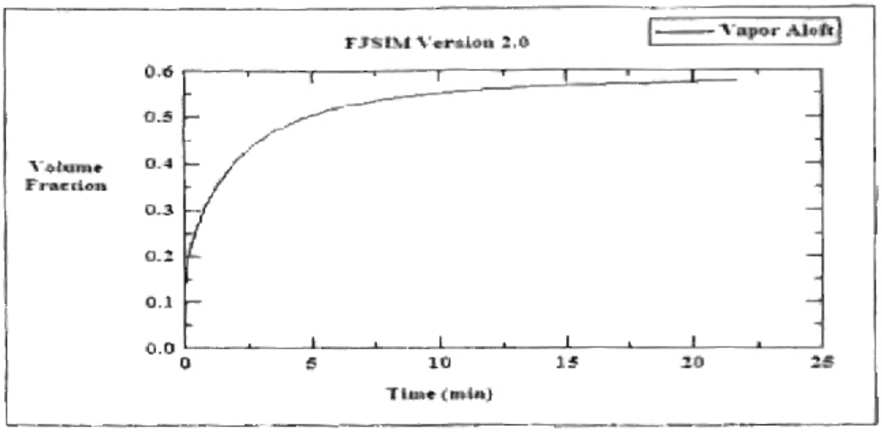


Figure 11: Example plot for vapor aloft time history plot

4.5.8 *Maximum deposition plot*

This plot, as shown in Figure 12, is the maximum deposition history of jettisoned fuel deposited on the surface. Maximum deposition time history plot shows how the maximum decreases with evaporation over a solid surface and the effects of evaporation and leveling out over water, from the initial maximum deposition level given in the deposition plots.

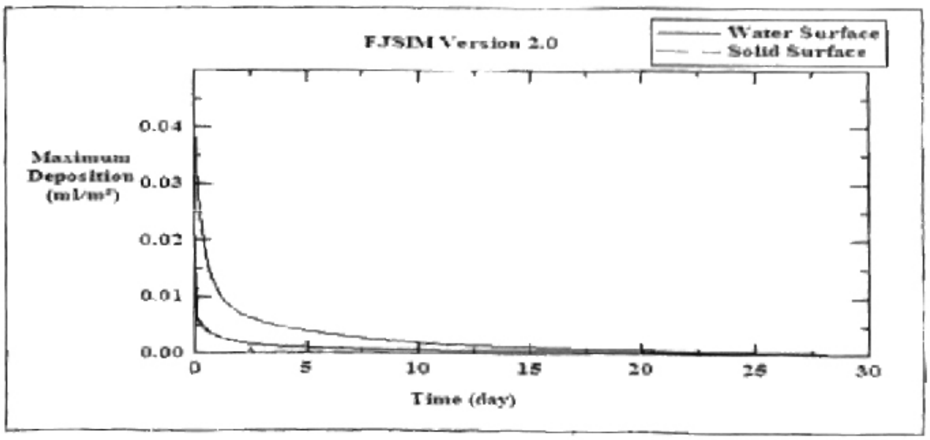


Figure 12: Example plot for maximum deposition

4.5.9 Surface evaporation

This plot, as shown in Figure 13, shows the fractional amount of jettisoned fuel deposited on the surface and continuing to evaporate. For jet fuels two curves are shown: evaporation from a water surface (upper curve) and evaporation from a solid surface (lower curve). For water jettisoning only one evaporation curve is shown.

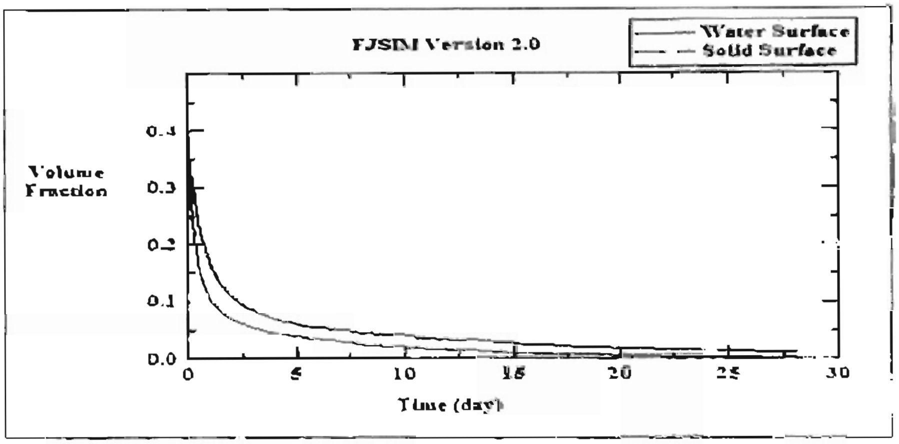


Figure 13: Example plot for surface evaporation

4.5.10 Numerical values

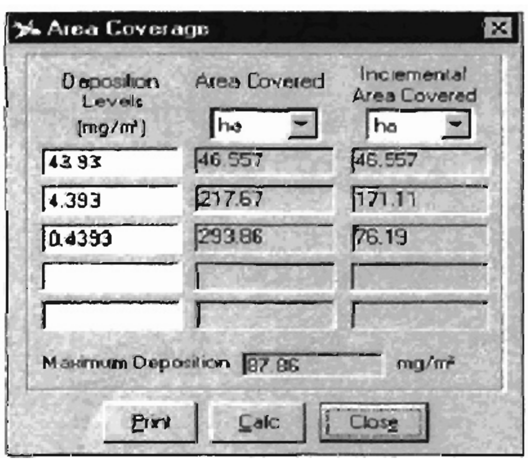
This screen displays computed results for the initial and final Drop Size Distribution (Volume Median Diameter VMD in micrometers); Deposition (Upwind and Downwind); Encounter Distances - the locations where one-half of the maximum surface deposition is first and last encountered when moving away from the aircraft flight path; Maximum Deposition Level; Total Amount Deposited on the Surface; and Total Accountancy (displaying all components of the released material, their initial volume fractions at jettisoning, and their remaining volume fractions at ground impact before surface evaporation, with totals on the Ground and Aloft given at the bottom of the screen).

4.5.11 Export

The Export screen selects the results for Export Drop Size Distribution (incremental), Drop Size Distribution (cumulative), Deposition Grid (Isopleths/Color map), Deposition Cross Section, Fraction Aloft Height History, Fraction Aloft Time History, Vapor Aloft Height History, Vapor Aloft Time History, Total Accountancy, Maximum Deposition, and Surface Evaporation; the Delimiter between the columns of data (tab, space, comma, user-defined character, or fixed width columns - with the width of the columns specified by the user); and Options (whether to add Header information to the file).

4.5.12 Toolbox

The toolbox consists of the 'Area Coverage' calculator and 'Drop Distance' calculator. The 'Area Coverage' toolbox recovers the area covered by given levels of deposition entered by the user as seen in Figure 14. In 'Drop Distance', as seen in Figure 14, the user enters an initial droplet size and altitude above the surface, and then invokes calculations to determine the fate of a fuel droplet of that size released into the meteorology specified in the FJSIM model at that height.



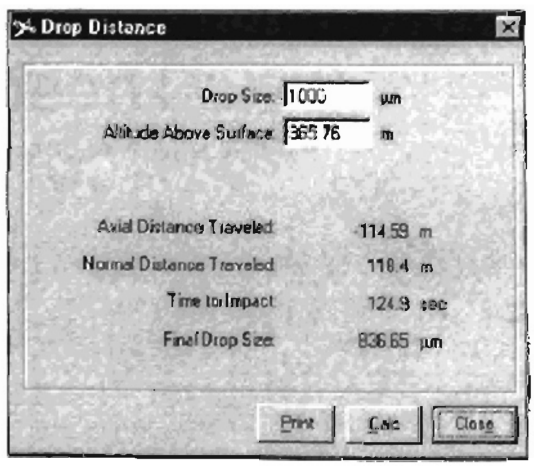


Figure 14: Toolbox screen

4.6 Introduction to Geographic Information System (GIS)

A Geographic Information System (GIS) is a computer system for capturing, storing, querying, analyzing, and displaying geographic data (Chang, 2002). Given the spatial nature of many environmental impacts, GIS can have a wide application in all Environmental Impact Assessment (EIA) stages, acting as an integrative framework for the entire process, from the generation, storage, and display of the thematic information relative to the vulnerability/sensitivity of the effected resources, to impact prediction and finally their evaluation for decision support (Antonic et al., 1999).

The rise of GIS technology and its use in a wide range of disciplines provides transportation and air quality modelers with a powerful tool for developing new analysis capability. The organization of data by location allows data from a variety of sources to be easily combined in a uniform framework (Charlot et al., 2001).

GIS has the ability to bridge the technical gap between the need of analysts and decision makers for easy understanding of the information. GIS involves two geographic data components: spatial features and attribute data. Spatial data relate to the geometry of spatial features and attribute data give the information about the spatial features.

A basic principle in GIS is that map layers to be used together must be based on the same coordinate system. Otherwise, map features from different layers will not register with one another spatially. GIS uses two basic data models to represent spatial features: vector and raster. The vector data model uses points and their x-, y- coordinates to construct spatial features of points, lines and areas. The raster data model uses a grid to represent the spatial variation of a feature.

Three primary modes of GIS use can be identified as map, query, and model. The map mode provides referential and browse information, when a user wishes to see an overview of a spatial realm, and needs to get a sense of what is there, sometimes in order to classify issues at hand. A query mode is used to address specific requests for information posed in two ways. One is that the user could specify a location and request information on phenomenon surrounding that location or nearby. A second is that a user could specify a kind of phenomena and request to see all locations where the phenomenon occurs. Model invocation is the third mode of use. After having prepared the nature of the inputs to be retrieved for a model, the model is run and an answer is computed (Nyerges, 1991). A classification of GIS activities is given in the Table 6.

TABLE 6:

A CLASSIFICATION OF GIS ACTIVITIES

Spatial data input	1. Data entry: use existing data, create new data 2. Data editing 3. Projection and re-projection 4. Geometric transformation
Attribute data management	1. Data entry and verifications 2. Database management
Data display	Use of maps, charts and tables
Data exploration	1. Attribute data query 2. Spatial data query 3. Geographic visualization
Data analysis	1. Vector data analysis 2. Raster data analysis 3. Terrain mapping and analysis 4. Spatial interpolation 5. Region based analysis 6. Network analysis
GIS modeling	1. Binary models 2. Index models 3. Regression models 4. Process models

Source: Kang-tsung Chang, 2002

4.7 Earlier application of GIS in emission modeling

The following section will briefly cover the past use of GIS in air quality analysis and the issue of spatial data quality.

Over the past few years, GIS has been used in many atmospheric models, mostly coupled with other systems. GIS was used for data input and management, preparation, displays and spatial analysis of the results, high quality mapping and user interfaces (Dragosits et al., 1996)

Models have been developed to estimate hourly emissions, which utilize GIS in developing mobile source estimates for input into photochemical models. A new prototype model system named AirGIS has been developed for Danish cities, which estimates ambient air pollution levels at high temporal and spatial resolution. The model system enables mapping of traffic emissions, air quality levels and human exposures (Jensen et al., 2001)

Likewise, Lin et al. (2002) described the application of GIS, in an air quality study in Taiwan, which integrates a vehicle emission model, pollutant dispersion model, backward trajectory model and related database to estimate the emission and spatial distribution of traffic pollutants in Taiwan. Dai et al. (1999) described new methodology that uses GIS to develop and integrate spatial data, to analyze spatial variations in emission and to derive input to cell based air pollution models in California.

Lee et al. (1991) have mentioned how GIS has become a natural choice for the reconciliation and storage of comprehensive geographical data sets of land surface characteristics that can provide surface boundary conditions for atmospheric models.

A GIS is an indispensable tool for emission inventory and air quality management. In addition to its powerful capabilities in processing, analyzing and modeling spatial data, GIS provides excellent visualization tools that can be used effectively to present emission inventory results and alternative solution to air pollution problems. Different GIS processing environment support different level of decision-making. A single GIS can take on many faces, depending on the requirements of the decision maker. Therefore, the use of GIS can improve not only the analytical capabilities for air quality management but also our ability to communicate work results and research findings to the decision makers and public in general.

Chapter 5

Computer Simulation Runs and Integration with Geographic Information System (GIS)

5.1 Simulations using historic meteorological data sets

Weather records from the period January 1996-December 2002 were examined to select meteorological data sets to use in the first series of the tests of the FJSIM model on Tinker AFB aircraft. Six to twelve days were selected from each month, depending upon the season, from the approximately six years of record. Number of days collected was larger in winter than summer, as during summer, the evaporation rate is higher and therefore, the possibility of the fuel reaching the ground is lower. Days were selected to give a wide range of the predominant weather conditions: hot, cold, windy and still. Atmospheric soundings in the text version from the Norman, Oklahoma (OUN) meteorological station were obtained from the archived data sets found from Department of Atmospheric Soundings, University of Wyoming, Laramie, Wyoming.

Meteorological data are collected at specific locations. These locations are called observing sites, observing stations or simply stations. An index number and/or a location indicator identify stations. Information about Norman Station from the National Oceanic and Atmospheric Administration (NOAA) are given in Table 7.

TABLE 7:

NORMAN METEOROLOGICAL STATION INFORMATION

Station Identifier	OUN
Station Number	72357
Station Name	Norman/ Max Westheimer
State	Oklahoma
Country	United States of America
Station Latitude	35.23N
Station Longitude	97.47W
World Meteorological Organization (WMO)	4
Station Elevation	357 meters
Upper Air Position	35-13N 097-27W
Upper Air Elevation	357 meters

Source: NOAA, 2002

An example of an atmospheric sounding is shown in Table 8. The full format of this sounding is shown in Table 2, Appendix B.

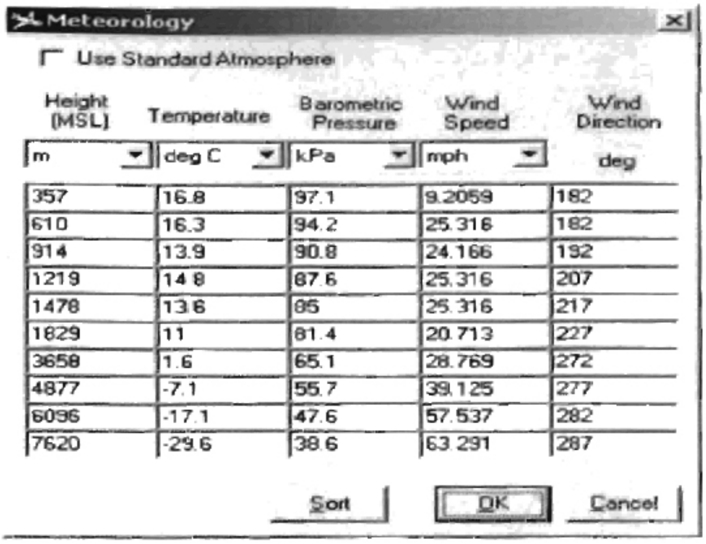
TABLE 8:

EXAMPLE SOUNDING HEADING FOR NORMAN, OKLAHOMA METEOROLOGICAL STATION

72357 OUN Norman Observations at 12Z 18 Nov 2002

PRES hPa	HGHT m	TEMP C	DWPT C	RELH %	MIXR g/kg	DRCT deg	SKNT knot	THTA K	THTE K	THTV K
1000.0	107									
971.0	357	16.8	1.8	36	4.51	190	8	292.4	305.8	293.2
942.3	610	16.3	-0.2	32	4.01	190	22	294.4	306.5	295.1
908.9	914	13.9	-1.6	34	3.77	200	21	295.0	306.4	295.7
876.5	1219	14.8	-13.1	13	1.60	215	22	299.0	304.1	299.3
814.8	1829	11.0	-14.5	15	1.54	235	18	301.3	306.3	301.6

The sounding heading lists the station, i.e., OUN Norman, and states that the sounding was obtained at 12:00 Universal Coordinated Time (6:00 AM Central Standard Time) on November 18, 2002. Meteorological properties used in the FJSIM model are listed in columns for PRES, HGHT, TEMP, DRCT and SKNT of the sounding. These are pressure (hPa), height (m), temperature (^{o}C), wind direction (degree magnetic) and wind speed (Kts) respectively. The entries in a sounding are listed in rows, by height in ascending order, starting at a theoretical height that corresponds to 1000 hPa. The meteorological data used for November 18, 2002, model in meteorological table are shown in Figure 15.



Height (MSL) m	Temperature deg C	Barometric Pressure kPa	Wind Speed mph	Wind Direction deg
357	16.8	97.1	9.2059	182
610	16.3	94.2	25.316	182
914	13.9	90.8	24.166	192
1219	14.8	87.6	25.316	207
1478	13.6	85	25.316	217
1829	11	81.4	20.713	227
3658	1.6	65.1	28.769	272
4877	-7.1	55.7	39.125	277
6096	-17.1	47.6	57.537	282
7620	-29.6	38.6	63.291	287

Figure 15: Meteorological table in the FJSIM model

Normal operating conditions were used for the aircraft simulated. All the runs presented in this report follow the jettison route specified in the Tinker AFB regulations, from 17NM to 32NM along the TACAN 142 radial as shown in Figure 16. Since the magnetic declination in the Tinker AFB area is approximately 8 degrees, the flight direction was aligned with 134 degrees. Other general conditions are for each aircraft are shown here;

B-1B Lancer:

Airspeed= 400 mph

Altitude = 20,000 feet AGL

JP-8 jettisoned= 12,000 lbs

E-3A AWACS:

Airspeed= 400 mph

Altitude= 20,000 feet AGL

JP-8 jettisoned= 6,000 lbs

KC-135 Stratotanker:

Airspeed= 400 mph

Altitude= 20,000 feet AGL

JP-8 jettisoned= 12,000 lbs

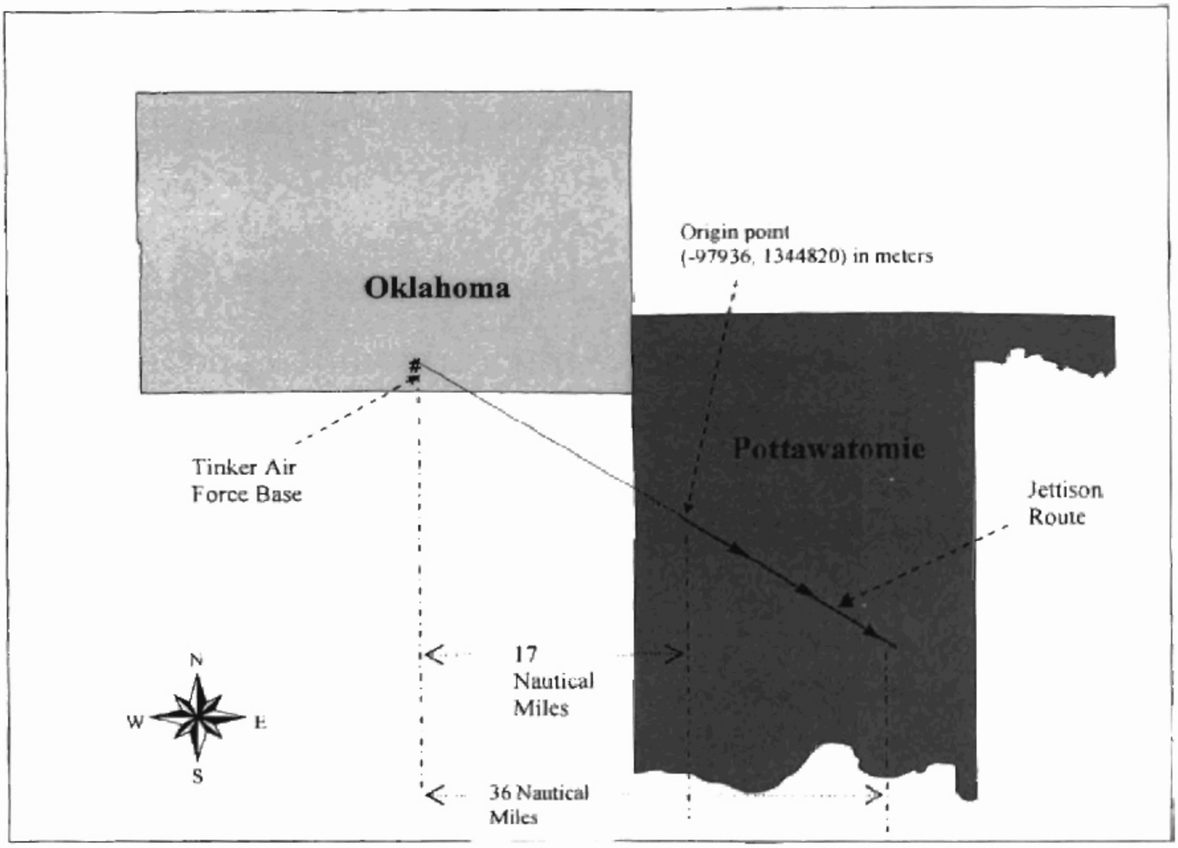


Figure 16: Location of the jettisoning route

The graphical entries selected for this report show important variables in the use of the model. The FJSIM outputs have been selected to demonstrate attributes of the model that should prove useful to the environmental decision-maker. The most important plots are the isopleths, plots showing lines of equal deposition on the ground. The isopleths are aligned with the 142-degree (magnetic) radial of the TACAN, i.e., 134 degree true. As for example, a model run for the B-1B on November 18, 2002, with the general operating conditions as discussed above as shown in Figure 17. The isopleth plot for this day is shown in Figure 18.

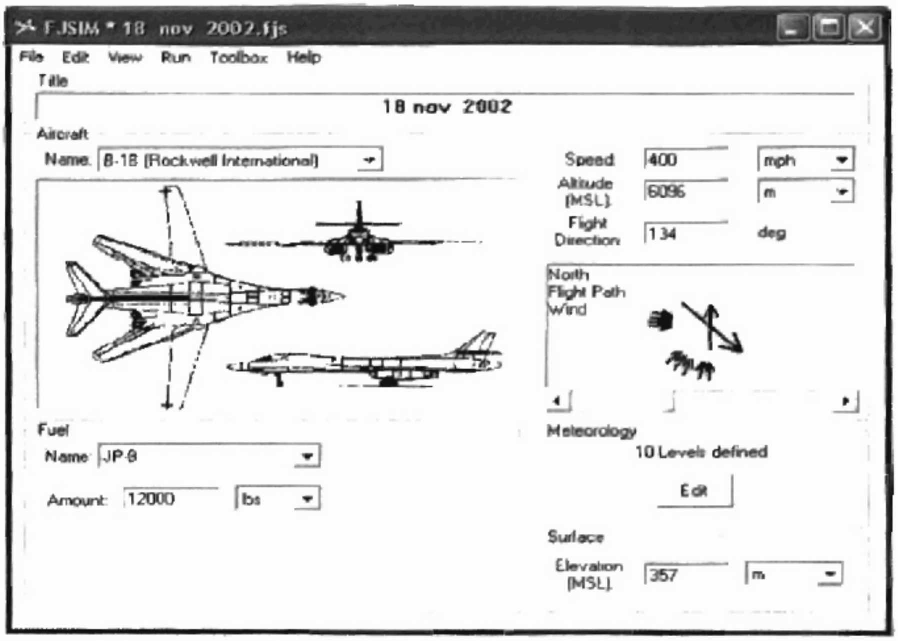


Figure 17: Input Parameters for the FJSIM model on November 18, 2002

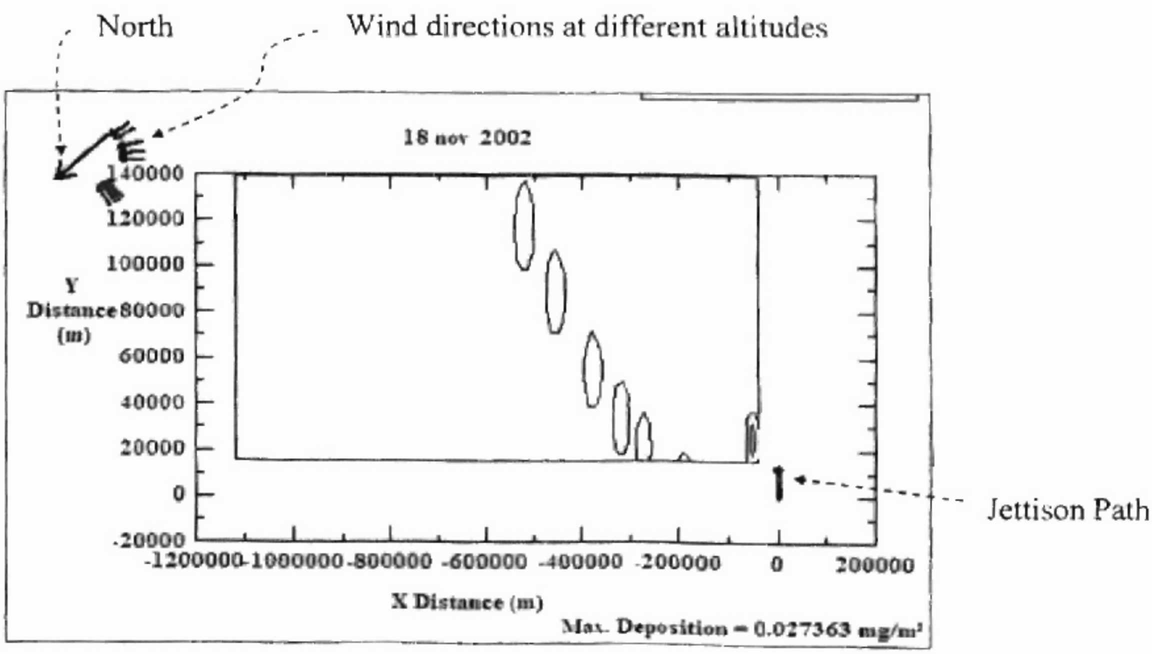


Figure 18: Deposition plot for B-1B on November 18, 2002

The inclined arrow at the upper left corner points to true north, the arrows surrounding the North arrow indicate wind speeds and the directions at various altitudes from the sounding data. The black solid arrow in the lower right corner of the plot shows the jettison path. The isopleth plots are always aligned with the jettison path pointing straight up.

The isopleths produced by the FJSIM model are then integrated with a GIS model in order to know immediately where the predicted contamination ground fall occurs if the jettison event occurred. The output of the FJSIM model was used as the input of the GIS model.

5.2 Coordinates of Tinker Air Force Base (TAFB) and the jettison route

A successful GIS system depends in large part on using projections correctly. A person's skills in managing and converting projections can dictate the value of a database. In order to display and analyze maps on the screen, a GIS system uses coordinates, which specify the location and shape of a particular feature. GIS users work with map features on a plane surface. These map features represent spatial features on the Earth's surface. The locations of a map features are based on a coordinate system, whereas the locations of spatial features are based on the geographic grid expressed in longitude and latitude values (Chang, 2002). The geographic grid is the location reference system for spatial features on the Earth's surface. These latitude-longitude values are in degrees, which are converted to meters. This conversion is termed as map projection in GIS.

Map projection attempts to portray the surface of the earth on a flat surface (Chang, 2002). Some distortions of distance, direction, scale and area always result from this process. A map is equidistant when it portrays distances from the center of the projection to any other place on the map. One of the most helpful things to understand about map projection is that it converts angular measurements, usually in degrees, to linear measurements such as miles, meters, etc.

ArcView 3.3 Projection Utility was used to project Albers-equal-area conic. The Albers-equal-area-conic is an equal area projection where the scale is true along the one or two selected standard parallels and the scale is constant along any parallel. The scale factor at a meridian at any given point is the reciprocal of that along the parallel to preserve equal area (Mathworks, 2003). This projection is not conformal (Chang, 2002). This map projection was chosen because the coordinate systems in other map layers were Albers-equal-area-conic. This projection helps us to convert degrees to meters as shown in Appendix C. Projection Utility is a wizard based utility in the ArcView package, which can project Shapefiles from geographic coordinates to a coordinate system, or re-project one coordinate system to another, or convert one datum to another (Chang, 2002). United States Geological Survey (USGS) has defined Shapefiles as digital vector (non-topological) storage format for storing geometric location and associated attribute information. The Shapefile format is created by ArcView and can be used by ArcView, ARC/INFO, ArcGIS and other widely used GIS software.

The jettison route was taken as the original point of the map as shown in Figure 16. The latitude and longitude in degrees were converted to state plane coordinates, which is a rectangular coordinate system. The state plane coordinate system was derived for greater user convenience with a rectangular grid superimposed over the latitude/longitude graticule, producing state plane coordinates in meters, yards or feet. In effect, this system assumes that the individual states are flat so they can be described by plane geometry rather than spherical grid. The method is applicable for small areas only as error due to failure to consider earth's curvature is not significant over relatively small areas.

The latitude and longitude of TAFB are 35.4147N and 97.38W respectively (National Atlas, 2003). The jettison route was described as along the TIK TACAN 142 radial from 17 to 32NM. In the GIS based map shown in Figure 16, it can be seen that TIK TACAN is 100 meters north of the main runway. A path 142 degree magnetic (not true, i.e., 134 degrees) was drawn outward from the TACAN. The jettisoning begins 17NM out from the TACAN and ends 32NM from the TACAN. The location of the jettison route was somewhere in Pottawatomie County as can be seen in Figure 16. The latitude and longitude of Pottawatomie County are 35.08N and 96.87 W (TIGER data, 2003). The new coordinates of that point with the help of Projection Utility were found to be (-97,936, 134, 482, 0) meters as shown in Appendix C.

5.3 Export data from the FJSIM model to Microsoft Access

The next task after finding out the coordinates of the jettison route is to export data from the FJSIM model to ArcView. In order to do that, we need to export data from the FJSIM model to Microsoft Access® 2000 (9.0.2720), which is a database management system that one can use for all information management, from a simple address to a complex inventory management system (Anderson, 1999). Deposition grid data is a very important output from the FJSIM model as it provides the X and Y values of the isopleth. With the help of these X and Y values, the predicted location of the plume in the real world can be found. Therefore, deposition grid (Isopleths/Colormap) data were exported from the FJSIM to Microsoft Access 2000. The information is stored in Microsoft Access in such a way that it can be retrieved and interpreted with flexibility and efficiency. Managing information means storing it efficiently and retrieving it quickly in such a form that can be instantly useful.

The procedures for exporting data from Deposition Grid (Isopleths/Colormap) from the FJSIM model to Microsoft Access are given below:

1. Open the FJSIM model / Run calculations
2. Open File/Export
3. Click "*Deposition Grid (Isopleths/Colormap)*" as shown in Figure 1, Appendix D
4. Check "*Include Headers*" as shown in Figure 1, Appendix D
5. Output/ Data Name (Preferably according to dates) and save it in text files format

Text files are useful when exporting data from many databases and importing or linking the data to Access tables. Fixed width or delimited text files can be imported or linked to an Access database using the same external data importing and linking function used for data from any source. The process for importing or linking text file to Access is given below;

1. In the MS Access, Table/New. Select "*Import Table*". In the Import window, select text files in the files of type box.
2. Find the text file that we want to import, as for example, *18 Nov, 2002.txt*. Click import as shown in Figure 2, Appendix D.

3. The Import Text Wizard dialog box appears, displaying sample data from the selected text file. The Import Text wizard actually analyzes the selected file and determines whether it is a fixed width test file or a delimited file. Figure 3, Appendix D shows that the text file that is imported, *18 Nov, 2002.txt*, has been determined to be delimited text file.
4. Click "*Next*" button on the Import Text Wizard. The second window in the series appears which confirms several things about our delimited file. We decided to go for tab delimited, which means that the fields in the file were delimited by tab.
5. Click "*First row contains Field names*", as shown in Figure 4, Appendix D.
6. Click "*Next*" button to see the third window in the Import Text Wizard. As we did not want to store our data in an existing table, click "*in a new table*" as shown in Figure 5, Appendix D.
7. Click "*Next*" button to see the data type. It is very important for our data type to be "*Double*" for all three fields as seen in Figure 6, Appendix D. Click "*Finish*" button to finish importing as shown in Figure 6, Appendix D.
8. Name the table, as for example, *Nov 18, 2002*

5.4 Designing of Queries in Microsoft Access

"Query" is a general term synonymous with question, inquiry, or quiz. In other words, a query is a question one asks of the database. With Access queries, one can view data from multiple tables sorted in a specific order. It also helps to perform many types of calculations on selected groups of records. The most important function of queries is that it can create a new table with records from one or more tables. We used this function to get the final X and Y coordinates with respect to the coordinates of jettison route.

As stated previously, the X and Y values we got from the deposition grid must be changed to fit the GIS coordinates. Therefore, our first step was to create a new table with new fields for X1 and Y1, which were the result of the transformation of the coordinates from the deposition grid with respect to the coordinates of the jettison route in Pottawatomie County.

In order to find our new coordinates with respect to our jettison route, i.e., 142-degree magnetic radial, we need to find the values of change in coordinates because of rotation. Changes of coordinates relate the coordinates of a point in one coordinate system to those of the same point in a different coordinate system. We use a transformation process to find the new coordinates (ScienceU, 1999). A transformation associates to each point (x,y) a different point in the same coordinate system. The equations used to get new coordinates because of rotation are given below;

$X1 = X \cos\alpha + Y \sin\alpha + C1$

$Y1 = -X \sin\alpha + Y \cos\alpha + C2$

$C1 = -97936$

$C2 = 1344820$

Where X1 and Y1 are new coordinates due to rotation and X and Y are coordinates we get from the FJSIM model. The derivations of these equations are given in Appendix E. C1 and C2 are constants, which are latitude and longitude of jettison area.

The processes for designing queries are discussed below;

1. Add a table to a query. The power of queries lies in being able to bring together or perform an action on data from more than one table or query.
2. In the "*Queries*" objects, click "*New*". Choose "*Design View*".
3. Choose table "*Input*" and click "*Add*" in order to add a table to a query.
4. It is necessary to add fields to a query. Drag from the field list to the query design list. Field list is a form and contains the names of all the fields in the record source. Design list is used to design a query. A query screen used is shown in Figure 19.

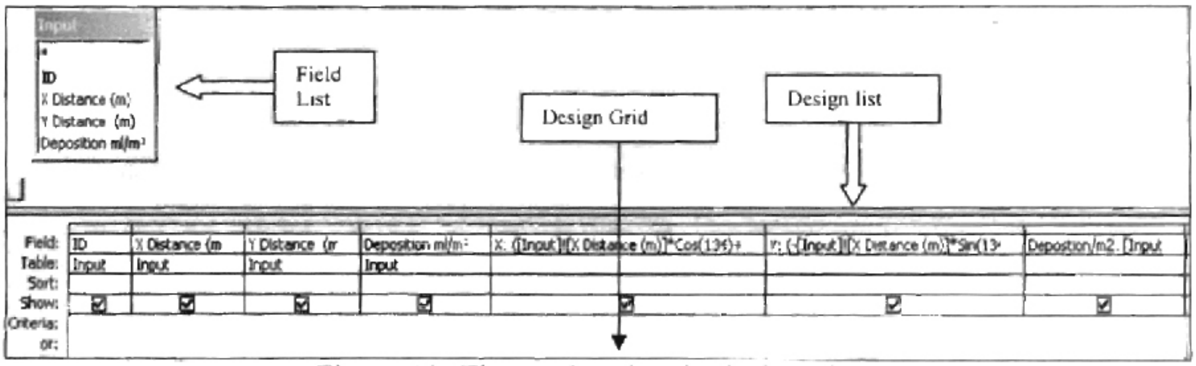


Figure 19: The work orders in design view

The content of each field is shown below;

Field 1: ID number

Field 2: X distance (meters) from Table "input"

Field 3: Y distance (meters) from Table " Input"

Field 4: Deposition (ml/m2) from Table " Input"

Field 5: X:([Input]![X Distance(m)]*Cos(134)+ [Input]![Y distance(m)]*Sin(134))-97936

Field 6: Y:(-[Input]![X Distance(m)]*Sin(134)+ [Input]![Y Distance (m)]*Cos(134))+1344820

Field 7: Depostion/m2: [Input]![Deposition ml/m²]*1000000000000000

Fields 5, 6 and 7 were built with the help of expression builder. If the expression includes a field name, one must place brackets around the name. As for example, [Input]. An expression is a combination of symbols. Symbol "!" is an identifier, which is an element of an expression that refers to the value of a field, or property. Here, values of "Input" in the table control the values of X, Y and Deposition/m^2. We need operators for operations to be performed on one or more elements. Expressions used are +, - and *.

5. In the criteria cell for the fields that we have dragged to the grid, type the criteria.
6. To preview the new table created, click "*View*" on the toolbar. After previewing, click "*Run*" on the toolbar to create a new table.
7. Name the query "*FJSIMRotate*".

5.5 Export data from Microsoft Access to ArcView

The next task was to get the new table for every run and export these outputs from Microsoft Access to ArcView. The processes for getting a new table and export it to ArcView software are given below:

1. Select the table that needs to be modified, as for example, *Nov 18, 2002.tx.t*
2. Rename the file to "*Input*" as the field list for our query is "*Input.txt*" as discussed in section 5.3, not *Nov 18, 2002.txt.*
3. Go to queries. Double click "*FJSIMRotate*" as shown in Figure 1, Appendix F. After clicking it, it asks if we want to modify data in our table. Click "Yes".
4. Go back to Tables. A new table "*Output*" with new fields can be seen. Rename it *Nov 18, 2002-output.*
5. In order to export this text file to ArcView, choose this file and click "*Export*".

6. Include " *Include Field names on first row*" as shown in Figure 2, Appendix F.

7. In ArcView, open Tables/Add/Export file from Access as shown in Figure 3, Appendix F.

8. Go to "*View*". Select "*Add Event Theme*", as shown in Figure 4, Appendix F.

9. As the number of data from the FJSIM model is in more than 5000 rows, we get rectangular shape consisting of large numbers of points, when we add the theme as can be seen in Figure 5, Appendix F.

10. In order to get the simulated plume shape, we need to take the help of query builder in ArcView. To build a query, we need to choose a field, then an operator, and a value. We can estimate the values from the deposition plots in the FJSIM model and choose those values in query builder. In this example, we know the deposition values from deposition plot shown in Figure 18 above. Figure 6, Appendix F shows the query builder in order to select 1.37E-05 from the rectangle to get the simulated plume shape. It needs to be noticed that the values were not limited to 1.37E-05, but ranged from 1.21E-05 to 1.41E-05 in order to get better shape of the plume. Likewise, other two deposition values can also be selected as shown in Figure 6, Appendix F.

11. After selecting these points, convert them to shapefiles as shown in Figure 7, Appendix F. Now, join these points to get a simulated plume shape. Add "*New Theme*", select "*Line*" and start joining the points.

12. After getting the plume shape, add different themes like counties of Oklahoma so that we can know the location of the simulated plume.

Chapter 6

Results and Discussions

6.1 Summary of runs

Several hundred simulation runs were performed for each aircraft using historical meteorological data sets for at least 6-12 days for each month from January 1996 through December 2002. The data sets for each aircraft are presented in Table 1 to Table 3, Appendix G. The data set for the selected simulations that were integrated with GIS are discussed in Table 12 and Table 13 below. These tables show the range of maximum ground level deposition of JP-8 fuel that could be found in the event a jettisoning incident occurred. It is not possible to perform a frequency analysis of the data because the selected data do not represent random samples from a normal population but a review of the summary data confirms that the vast majority of jettison events would result in extremely low predicted surface depositions.

From all the simulated summaries, it can be seen that most jettisoning events would result in maximum ground level deposition of JP-8 fuel below 1 mg/m^2 if the fuel were jettisoned from 20,000 feet AGL. Most of the runs were performed at 20,000 feet AGL, as stated in the regulation that the fuel be jettisoned at or above 20,000 feet whenever possible. However, 5,000 feet AGL was used for worst-case testing for some days, as stated in the regulation that the fuel not be jettisoned below 5,000 feet AGL.

Table 1 in Appendix G shows the summary of runs from 1996 to 2002 for the B-1B Lancer. The maximum deposition ranged from 0.001753 mg/m^2 in 1998 to 0.674 mg/m^2 in 2001. Table 9 below shows the range of maximum deposition for the B-1B Lancer from 1996 to 2002 when the simulated fuel was jettisoned from 20,000 feet AGL.

TABLE 9:

RANGE OF MAXIMUM DEPOSITION FOR THE B-1B LANCER

Year	Maximum deposition (mg/m^2)				Maximum deposition (mg/m^2)			
	Date	Ground level (MSL)		Max Value	Date	Ground level (MSL)		Min Value
		Temp (°C)	Wind speed (mph)			Temp (°C)	Wind speed (mph)	
1996	3 Feb	-17.1	13.8	0.5930	28 April	21.8	37.97	0.00368
1997	10 Nov	1.8	19.53	0.337	1 July	23	6.9	0.003221
1998	31 Jan	6	6.90	0.863	7 May	23.6	9.20	0.001753
1999	1 Feb	4.4	6.90	0.635	4 June	21.8	9.20	0.004645
2000	23 April	0.4	13.8	0.7918	20 July	24.4	6.90	0.00894
2001	1 May	0	11.5	0.674	2 July	29.2	9.20	0.003412
2002	1 Feb	0.4	14.9	0.635	11 May	19.8	11.5	0.004087

As mentioned before, the fuel was jettisoned from 5,000 feet AGL in order to test worst-case scenarios. The maximum deposition was found to be 8.95 mg/m^2 on 29 April, 1998. However, it needs to be noticed that the simulated fuel was jettisoned from 6,000 feet AGL. The maximum deposition was found to be 8.03 mg/m^2 on 17 December, 1999, when the fuel was jettisoned from 5,000 feet AGL in this simulation for the B-1B, as seen in Table 1, Appendix G.

Table 2, Appendix G shows the summary of runs from 1996 for the KC-135 aircraft. The maximum deposition ranged from 0.00134 mg/m^2 in 1998 to 0.8363 mg/m^2 in 1999. Table 10 below shows the range of maximum deposition for the KC-135 from 1996 to 2002 when the simulated fuel was jettisoned from 20,000 feet AGL.

TABLE 10

RANGE OF MAXIMUM DEPOSITION FOR THE KC-135 STRATOTANKER

Year	Maximum deposition (mg/m^2)				Maximum deposition (mg/m^2)			
	Date	Ground level (MSL)		Max Value	Date	Ground level (MSL)		Min Value
		Temp (°C)	Wind speed (mph)			Temp (°C)	Wind speed (mph)	
1996	9 March	-6.1	4.603	0.6834	28 April	21.8	37.9	0.00472
1997	8 Feb	-2.7	13.8	0.3944	1 July	23	6.9	0.002139
1998	19 Feb	6	6.90	0.55	14 Sept	22.6	6.9	0.001135
1999	20 Dec	-2.3	13.8	0.8363	22 June	21.6	9.2	0.00134
2000	9 Nov	0.4	13.8	0.27	1 Nov*	16.4	13.8	0.003294
2001	27 March	0	11.5	0.419	1 Nov	20	19.5	0.004872
2002	11 Dec	6.2	8	0.264	2 April	24	14.96	0.002534

As mentioned before the fuel was jettisoned from 5,000 feet AGL in this simulation for the KC-135 in order to test the worst-case scenarios. The maximum deposition was found on 13 October 1997, when the deposition was 9.21 mg/m^2, as can be seen in Table 2, Appendix G.

* High temperature, very strong and consistent upper level wind speeds and wind directions with altitudes on Nov 1, therefore, so much difference in maximum deposition within 8 days

Summary results for the E-3A Sentry are given in Table 3, Appendix G. Table 11 below shows the range of maximum deposition for the E-3A Sentry from 1996- 2002 when the fuel was jettisoned from 20,000 feet AGL.

TABLE 11

RANGE OF MAXIMUM DEPOSITION FOR THE E-3A SENTRY

Year	Maximum deposition (mg/m^2)				Maximum deposition (mg/m^2)			
	Date	Ground level at (MSL)		Max Value	Date	Ground level at (MSL)		Min Value
		Temp (°C)	Wind speed (mph)			Temp (°C)	Wind speed (mph)	
1996	3 Feb	-17.1	13.8	0.4	28 April	21.8	37.974	0.002613
1997	8 Feb	-2.7	13.8	0.70	1 July	23	6.9	0.001970
1998	14 Jan	-1.1	6.90	0.52	7 May	26.6	9.20	0.00912
1999	1 Feb	4.4	6.90	0.3372	1 June	22	13.8	0.0027
2000	9 Nov	0.4	13.8	0.516	1 Nov	21.6	9.2	0.00178
2001	3 March	0	11.5	0.373	1 Nov	16.4	13.8	0.00292
2002	3 March	-12.5	9.20	0.325	11 May	19.8	11.5	0.002256

As mentioned before, the fuel was jettisoned from 5,000 feet AGL in this simulation to test worst-case scenarios, which is shown in Table 3, Appendix G.

6.2 Selected Simulations

From the summary of runs, we selected some days and integrated the result with the GIS. The selected simulations are summarized in Table 12 and Table 13. Table 12 shows the meteorological data and aircraft conditions at the time of simulated jettisoning events.

TABLE 12:

METEOROLOGICAL DATA OF THE SELECTED SIMULATED DAYS

Date	Ground level condition(MSL)			Aircraft condition		Simulated jettisoned altitude (MSL)		
	Events*	Temp (°C)	Wind speed (mph)	Speed (mph)	Fuel jettisoned (lbs)**	Altitude (ft)	Temp (°C)	Wind Speed (mph)
3 Feb 1996	Fog, Snow	-17.1	13.809	400	12000	20000	-33.5	88.6
10 March 1996	N/A	-9.1	11.507	400	12000	20000	-28.9	82.5
12 Dec 2000	Snow	-8.5	16.11	400	12000	20000 5000	-17.1 -13.3	73.67 47.18
1 Aug 2001	N/A	25	97.7	400	12000	20000	-5.2	11.507
15 Dec 1998	N/A	1	4.603	400	12000	20000	-20.2	19.56
4 Feb 1996	N/A	-17.7	4.603	400	12000	20000 5000	-29.3 -11.1	105.87 32.221
1 May 1999	N/A	11.8	9.2059	400	12000	20000	-14.4	24.166
29 April 1999	Rain	12.4	13.809	400	12000	20000	-18.9	14.9
12 Sept 1996	N/A	20.6	10.357	400	12000	20000	-10.3	24.166
13 March 1999	Fog, Rain, Snow	1	11.597	400	12000	20000	-26.9	78.25

Source: Atmospheric Soundings, University of Wyoming

**Source: Wunderground, 2003*

** 6,000 lbs of fuel was jettisoned for the E-3A

The maximum depositions from the simulated jettisoning events on these selected days from all three aircraft are summarized in Table 13.

TABLE 13:

MAXIMUM DEPOSITIONS OF THE SELECTED SIMULATED DAYS

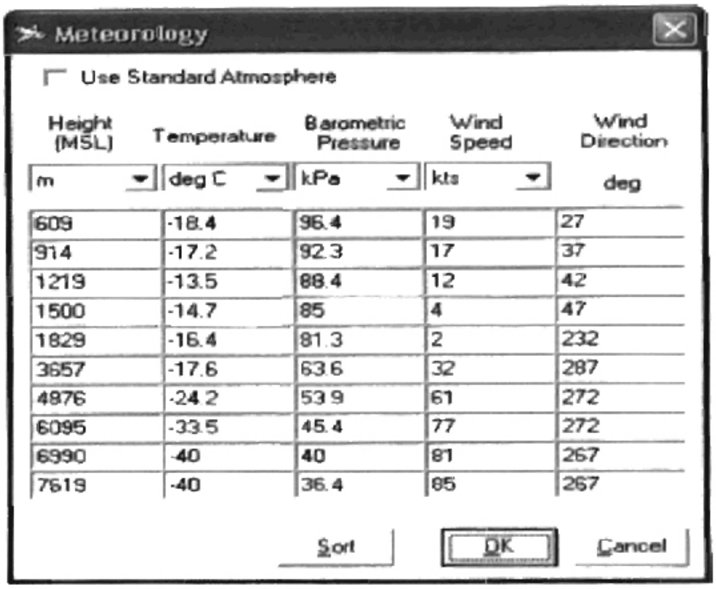
Date	Maximum deposition for the B-1B		Maximum deposition for the KC-135		Maximum deposition for the E-3A	
	ml/m^2	mg/m^2	ml/m^2	mg/m^2	ml/m^2	mg/m^2
3 Feb 1996	4.630E-04	0.41427	5.056E-04	0.45249	2.807E-04	0.25125
10 March 1996	4.047E-04	0.37176	4.397E-04	0.40293	2.42E-04	0.22305
12 Dec 2000	1.91E-04 0.004216**	0.11 3.62	1.288E-04 0.004613	0.1212 3.91	7.15E-05 0.0025	0.069 2.16
1 Aug 2001	9.00E-06	0.0086715	9.71E-06	0.009575	5.12E-06	0.005059
15 Dec 1998	1.75E-04 6.03E-04*	0.17352 0.60046	1.05E-04 6.53E-04	0.103 0.64	1.059E-04 3.65E-04	0.10503 0.35
4 Feb 1996	4.35E-04 0.0181**	0.397 16.172	4.707 0.0201	0.4242 17.472	2.611E-04 0.01133	0.2377 9.6689
1 May 1999	9.66E-05	0.09697	1.021E-04	0.10247	5.76E-05	0.057853
29 April 1999	2.04E-04	0.2011742	2.53E-04	0.249	1.43E-04	0.1410
12 Sept 1996	2.74E-05	0.027	3.59E-05	0.0342	1.98E-05	0.019982
13 March 1999	2.68E-04	0.2578	2.89E-04	0.27846	1.608E-04	0.15462

*Only surface level meteorological data used

** When the simulated fuel was jettisoned from 5,000 feet AGL

Each selected simulated run is discussed in this chapter individually. The outputs of the FJSIM model on these days were integrated with the GIS software in order to know the affected locations from the simulated jettisoning events, which are discussed in the following paragraphs.

One of the worst-case situations that could be seen at Tinker AFB was a cold winter day with reasonably stable atmosphere. The best-suited example for such condition was on February 3, 1996, when the winds on this date were somewhat low for Oklahoma, but not calm. Table 3, Appendix B shows the atmospheric sounding for this date. The entries used for this day in the meteorological table of the FJSIM model are shown in Figure 20.


Meteorology

Use Standard Atmosphere

Height (MSL)	Temperature	Barometric Pressure	Wind Speed	Wind Direction
m	deg C	kPa	kts	deg
609	-18.4	96.4	19	27
914	-17.2	92.3	17	37
1219	-13.5	88.4	12	42
1500	-14.7	85	4	47
1829	-16.4	81.3	2	232
3657	-17.6	63.6	32	287
4876	-24.2	53.9	61	272
6095	-33.5	45.4	77	272
6990	-40	40	81	267
7619	-40	36.4	85	267

Sort OK Cancel

Figure 20: Meteorology of the FJSIM model at OUN Norman, Oklahoma, on February 3, 1996

From Figure 20, we can find that the temperature at 6095 meters was –33.5°C, wind speed was 77 knots and wind direction was 272 degrees (magnetic). The input values were used as given in general conditions above, i.e., 12,000 lbs of fuel jettisoned from 20,000 feet AGL and aircraft speed was 400 mph for the B-1B Lancer. Figure 21 is the isopleth, the plot of areas of equal ground level deposition of jettisoned fuel. The plot shows that the maximum deposition is 0.41427 mg/m^2.

Figures 21, 22 and 23 show the outputs for the B-1B Lancer on this day.

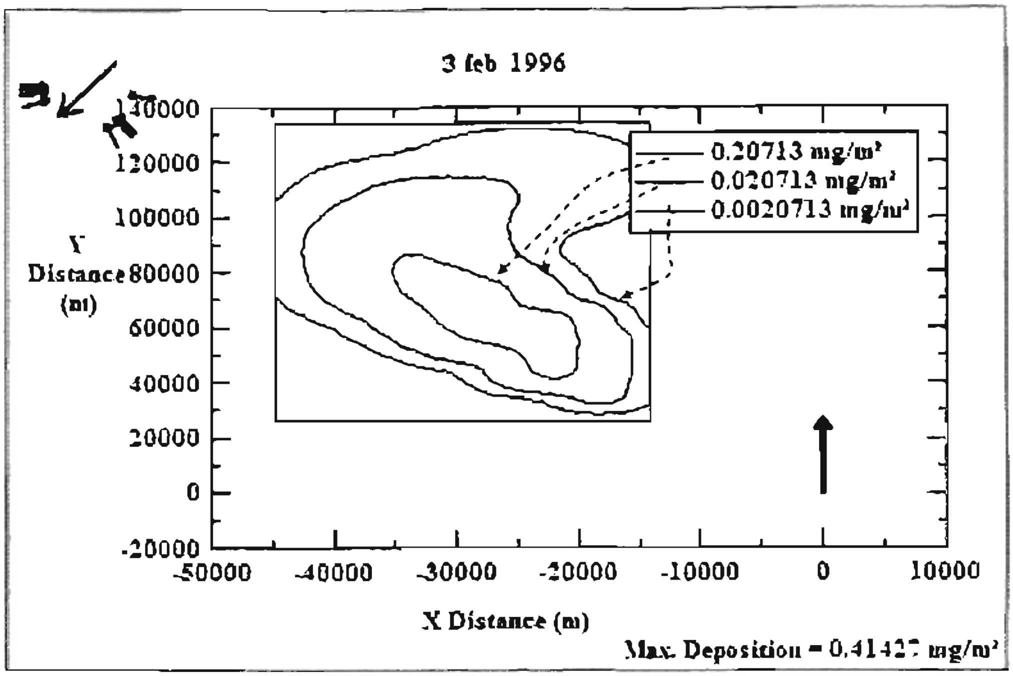


Figure 21: Isopleth Deposition Plot

The plot in Figure 21 shows that the area of maximum ground level deposition was approximately 70,000 meters southwest of the jettison route. The area is shown large and far removed from the base, but the depositions are so low as to be undetectable.

Figure 22 shows that most of the fuel remains at an altitude of approximately 5500 meters (18,000 feet), which is below the jettisoning altitude. Around 30% of the fuel started coming down to the ground. Almost 2% of the fuel i.e., 240 lbs, reaches the ground. The potential impact of this jettisoned fuel is presented later.

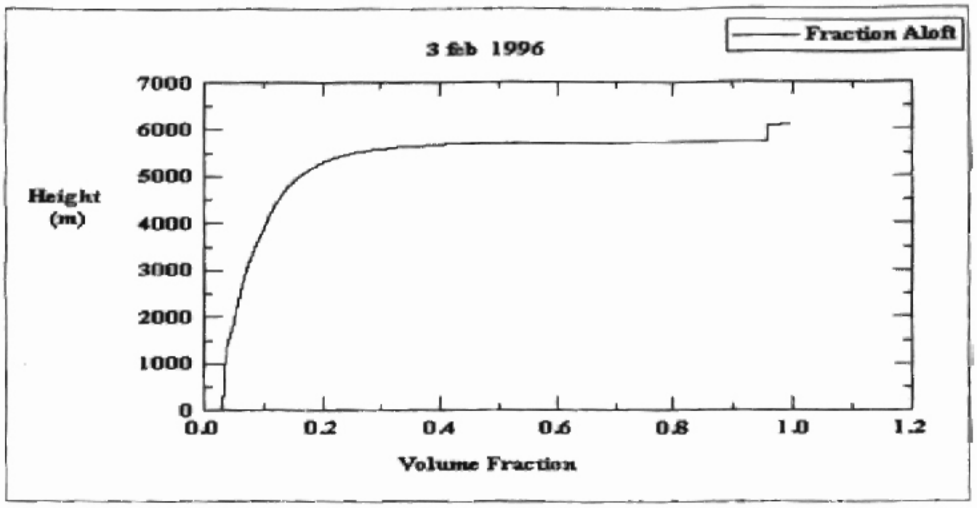


Figure 22: Plot of Volume Fraction aloft with Height

The maximum deposition seen in Figure 23 takes into account the evaporation of the fuel from the land surface. Fuel evaporates from soils at different rates from water therefore, two lines are shown on the plot. When the maximum deposition was initially high on the solid surface, it dropped rapidly in the days following the jettisoning events.

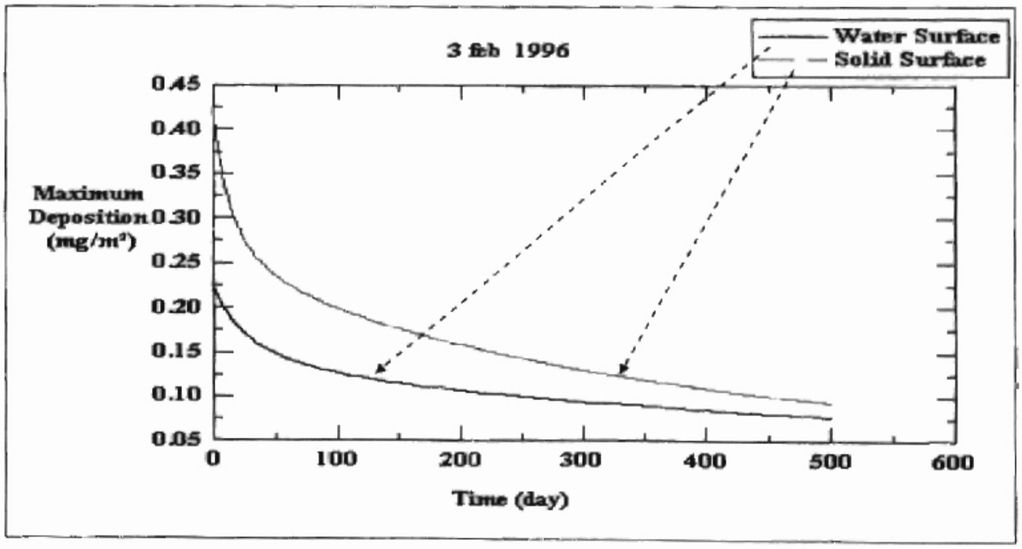


Figure 23: Maximum Deposition Time History Plot

Likewise, the study was made for the KC-135 and the E-3A. Figure 24 shows the output of the KC-135 for this day.

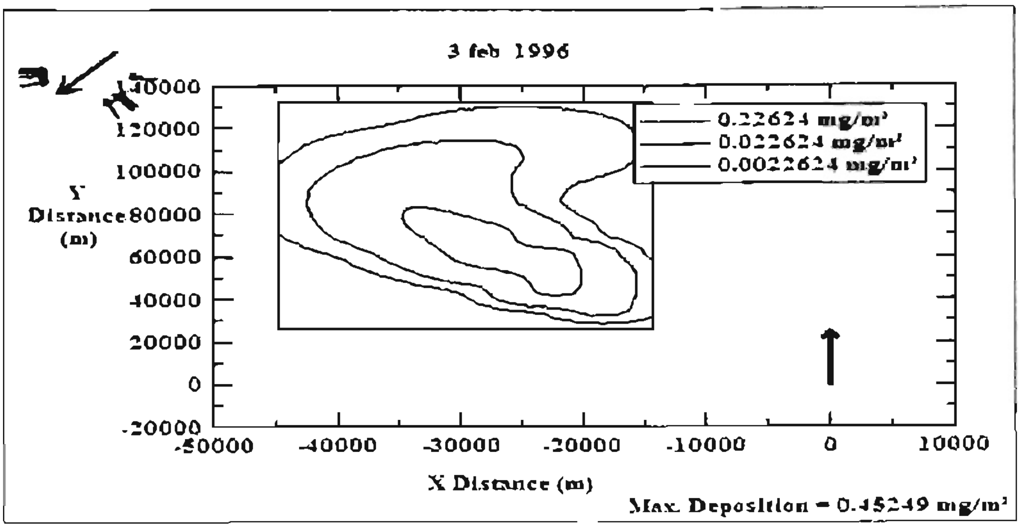


Figure 24: Isopleth Deposition Plot for the KC-135

The model was run for the KC-135 with the same input values as used for the B-1B Lancer, as shown in Figure 2, Appendix H. The maximum deposition has slightly increased to 0.45249 mg/m^2 in this case, giving an idea that maximum deposition varies with the aircraft type even though the same input values were applied for different aircraft because of the jettison rate of the aircraft. Comparison of the output plots on February 3, 1996, in Appendix H, Figure 3- Figure 7 show that the rest of the plots were the same for the KC-135 and the B-1B. This might be due to the reason that the meteorological data for these aircraft were the same.

The model was run for the E-3A Sentry. Initially, the input values were the same values used for the B-1B and the KC-135 as shown in Appendix H, Figure 8(a). However, the flight path did not correspond to the 17-32 Nautical Miles jettison route specified in Tinker AFB regulations 60-1 as shown in Figure 25.

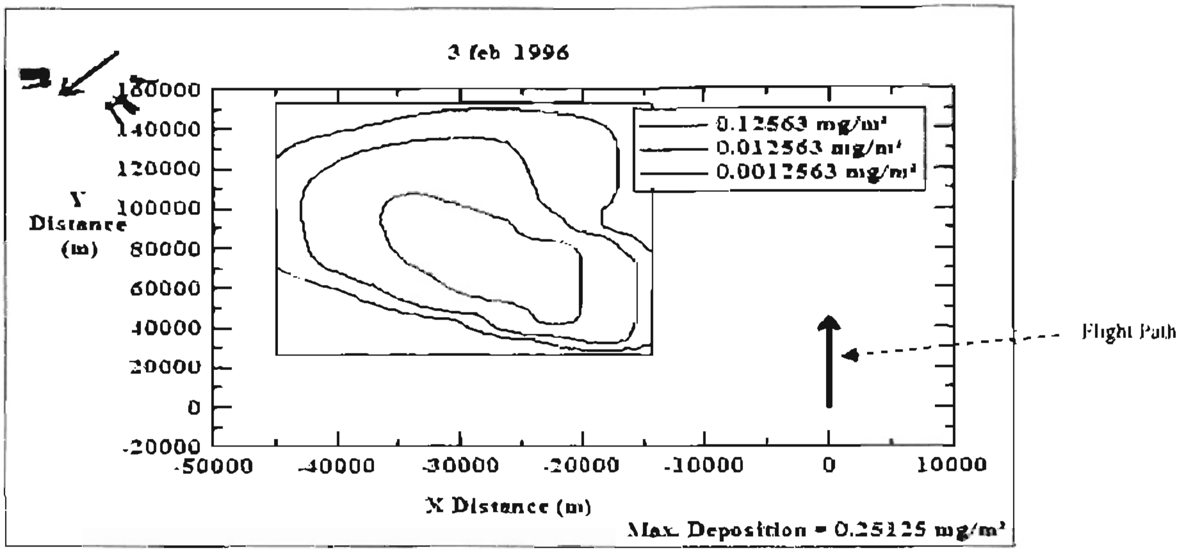


Figure 25: Deposition Isopleth Plot when the amount of fuel was 12,000 lbs for the E-3A

In order to maintain the jettisoning route of 17-32 NM, the amount of fuel jettisoned was decreased from 12,000 lbs to 6,000 lbs as shown in Appendix H, Figure 8 (b). The output isopleth is shown in Figure 26, where the flight route is between 17-32 NM.

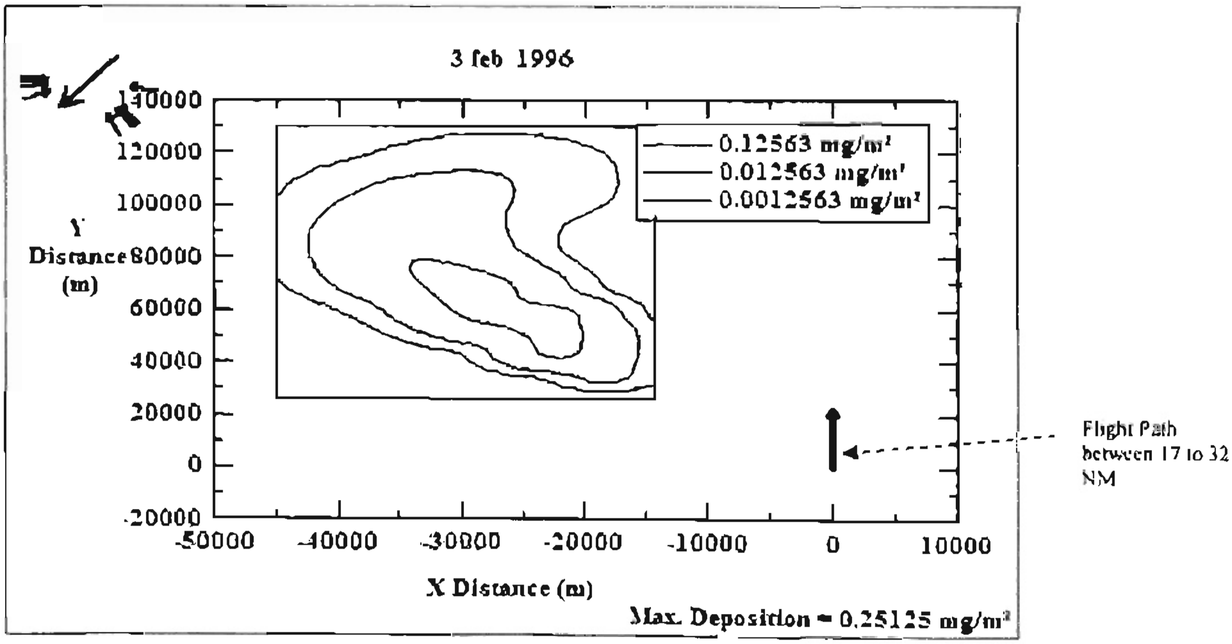


Figure 26: Deposition Isopleth Plot when the amount of fuel was 6,000 lbs for the E-3A

It needs to be stressed that changing the amount of fuel jettisoned by a given aircraft does not change the maximum ground level deposition. Therefore, it can be concluded from this simulation that maximum deposition is not related to the amount of fuel jettisoned, but, depends on the jettison rate of the aircraft. However, it changes the shape of the isopleth. The total amount of fuel reaching the ground also slightly decreased after the amount of fuel was decreased as can be seen in Figure 9 (a) and Figure 9 (b), Appendix H. Other output comparisons are shown in Figure 10-Figure 12, Appendix H.

As the isopleths for all three aircraft were similar and located at almost same location, only one aircraft's run was incorporated with the GIS. The isopleth plume from the B-1B Lancer was selected. The GIS based map for this condition is shown in Figure 27.

Figure 27 shows that the simulated groundfall was in Seminole, Hughes and Pottawatomie Counties. The plume started at 18,000 meters east of jettison area in Pottawatomie County and was inclined towards the southeast direction. The maximum deposition was 0.41427 mg/m^2. The default contour level reflects the ½, 1/20th and 1/200th the maximum deposition in Figure 27.

Figure 28 shows the predicted counties of Oklahoma that were affected by the simulated jettison event on this day. It can be seen from this figure that southeast area of Pottawatomie County was affected by this simulated jettisoning event.

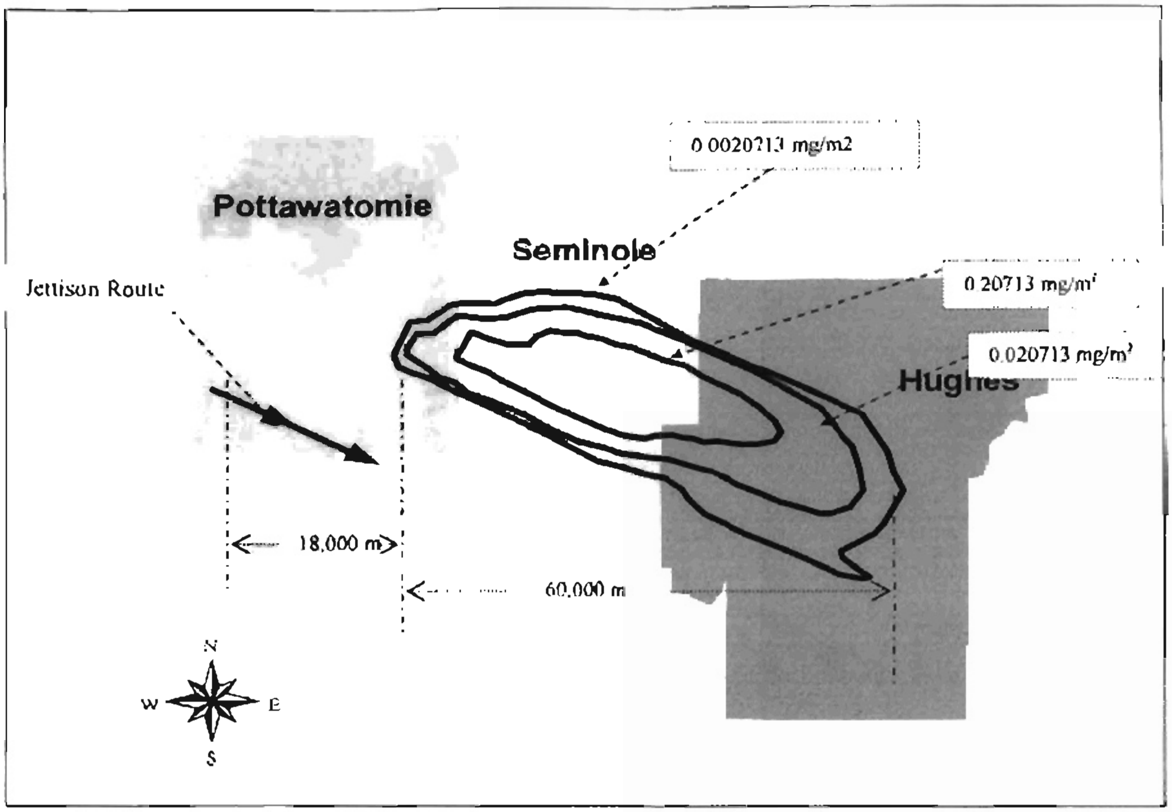


Figure 27: Distribution of the simulated plume due to fuel jettison on February 3, 1996

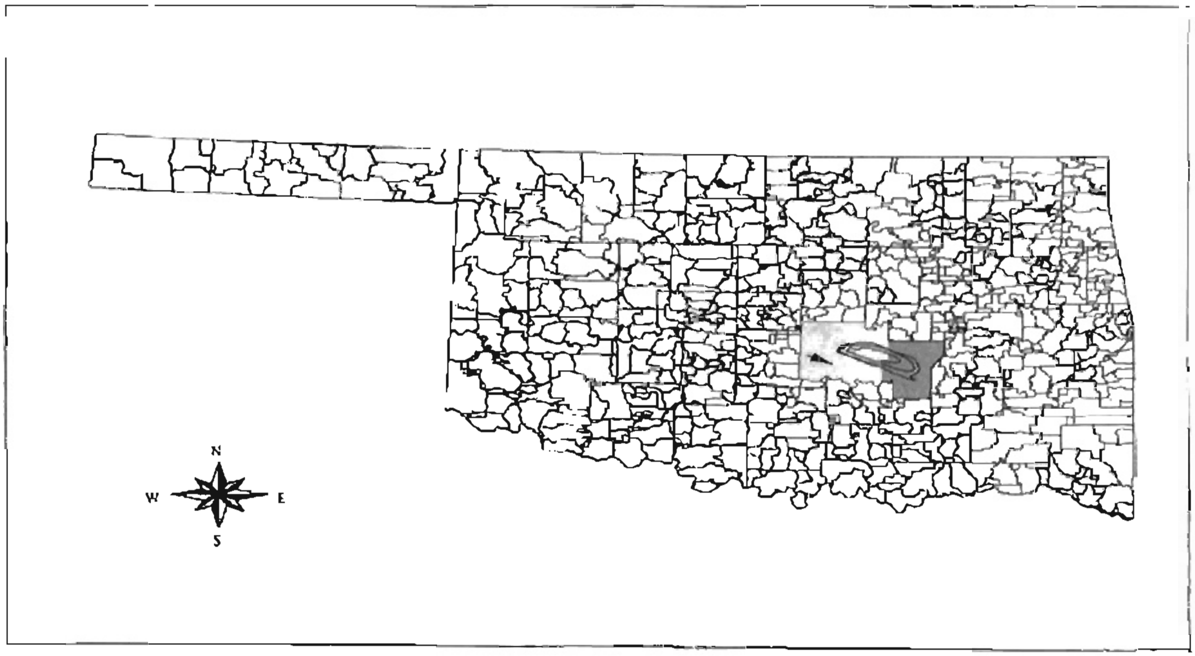
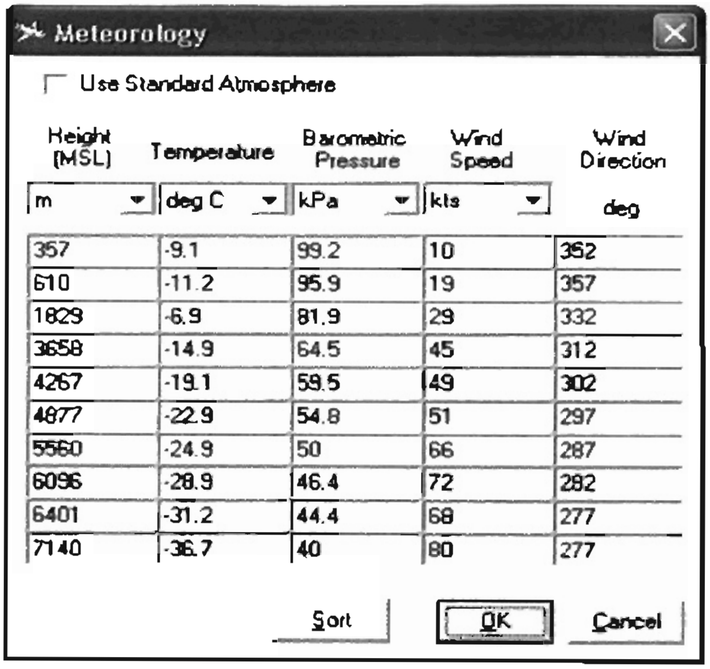


Figure 28: Simulated affected counties in Oklahoma on February 3, 1996 due to fuel jettison

Another interesting day was March 10, 1998. It was a cold winter day with ground temperature –9.1°C and ground wind speed 10 kts as can be seen in Figure 29. The FJSIM model was run for all three aircraft. The simulated altitude at which the fuel was jettisoned was considered 20,000 feet AGL for all three aircraft as can be seen in Figure 13 (a) – Figure 13 (c), Appendix H. The atmospheric sounding for this day is shown in Table 4, Appendix B. The entries used for this day in meteorological table of the FJSIM model are shown in Figure 29.



Height (MSL) m	Temperature deg C	Barometric Pressure kPa	Wind Speed kts	Wind Direction deg
357	-9.1	99.2	10	352
610	-11.2	95.9	19	357
1829	-6.9	81.9	29	332
3658	-14.9	64.5	45	312
4267	-19.1	59.5	49	302
4877	-22.9	54.8	51	297
5560	-24.9	50	66	287
6096	-28.9	46.4	72	282
6401	-31.2	44.4	68	277
7140	-36.7	40	80	277

Figure 29: Meteorology of the FJSIM Model at OUN Norman, Oklahoma, on March 10, 1998

At 20,000 feet (6096 m) AGL, the atmospheric temperature was –28.9°C, wind speed was 72 knots, and wind direction was 282 degrees (magnetic) north. Upper level winds were strong and more consistent with altitudes as can be seen in wind speed column in meteorology table. Figure 30 shows the output of the B-1B Lancer from the FJSIM model for this day.

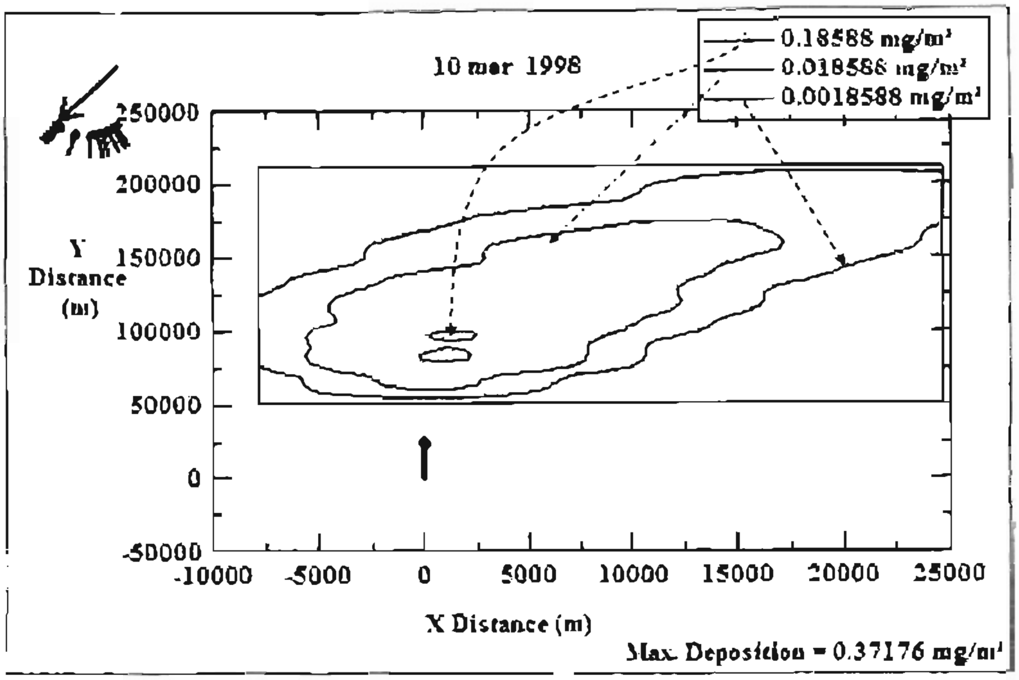


Figure 30: Isopleth Deposition Plot for the B-1B Lancer

Figure 30 shows that the isopleth area was much larger than the isopleth of the previous example, i.e., Feb. 3, 1996. This means that the distribution of the simulated plume was larger on this day. The impact of the stronger and more consistent upper level winds with altitudes on this day is evident when Figure 30, showing the isopleth for the B-1B on March 10, 1998, is compared to Figure 21, showing the isopleth for the same aircraft with the same operating conditions. The maximum deposition is 0.37176 mg/m^2, which is almost 22% lower as compared to February 3, 1996 but the area impacted ground surface has increased. The plot shows that the area of maximum ground level deposition is spread on both sides of the jettison route. Figure 31 shows the location of the simulated plume above Oklahoma. The simulated affected counties were Hughes, Pittsburg, Coal, Pushmataha, McCurtain, Choctaw and Atoka. Figure 32 shows the affected counties in Oklahoma from this simulated jettison event.

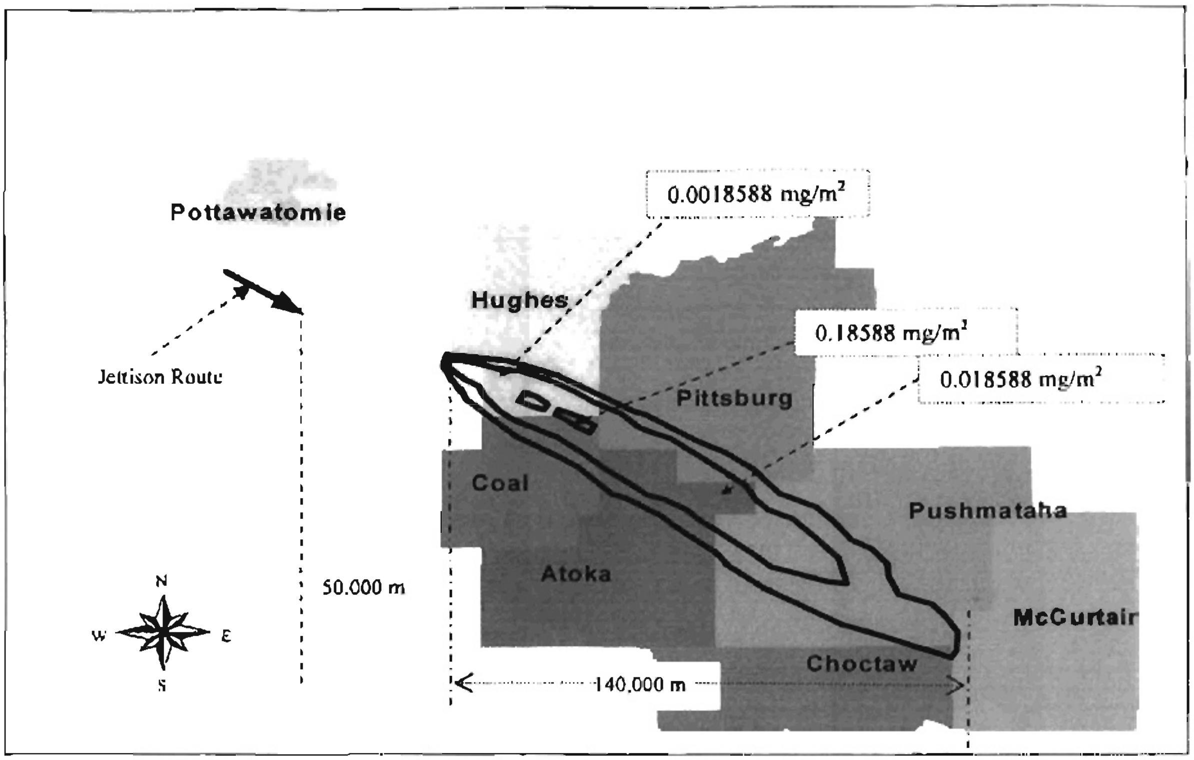


Figure 31: Distribution of the simulated plume on March 10, 1998

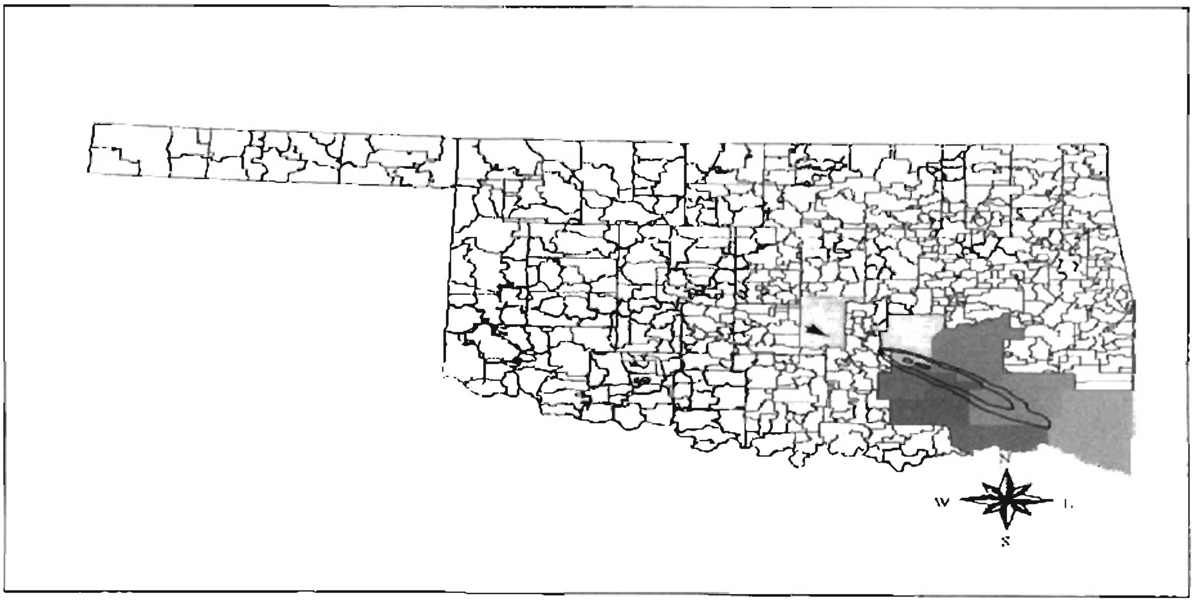


Figure 32: Simulated affected counties on March 10, 1998

Figure 33 shows that around 90% of the jettisoned fuel dropped from 20,000 feet AGL to approximately 18,000 feet AGL. Most of the fuel remained constant at this altitude till the volume fraction reached 0.2, which is 20% of the jettisoned fuel, and started dropping. Almost 1.5% of the fuel reached the ground this day, as was indicated in the tabular data from the run, Table 1, Appendix G.

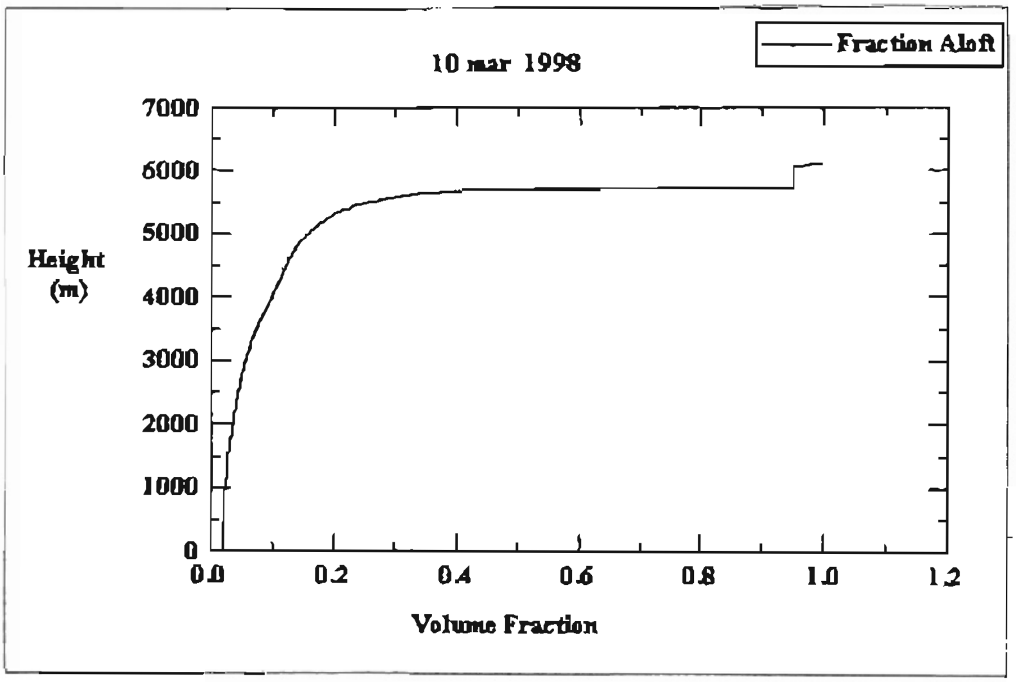


Figure 33: Plot of volume fraction aloft with height

The model was run for the KC-135 with the same input values as used for the B-1B as can be seen in Figure 13 (b), Appendix H. The maximum deposition value increased from 0.37175 mg/m^2 to 0.40293 mg/m^2 as can be seen in Figure 34.

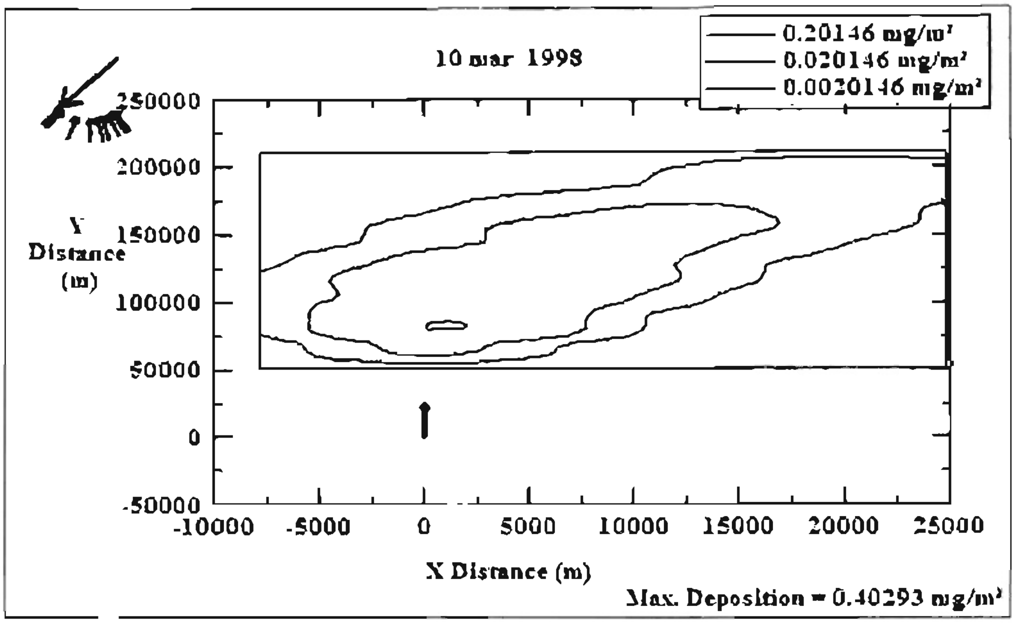


Figure 34: Deposition Isopleth Plot for the KC-135

The model was run for the E-3A. The isopleth from this run is shown in Figure 35.

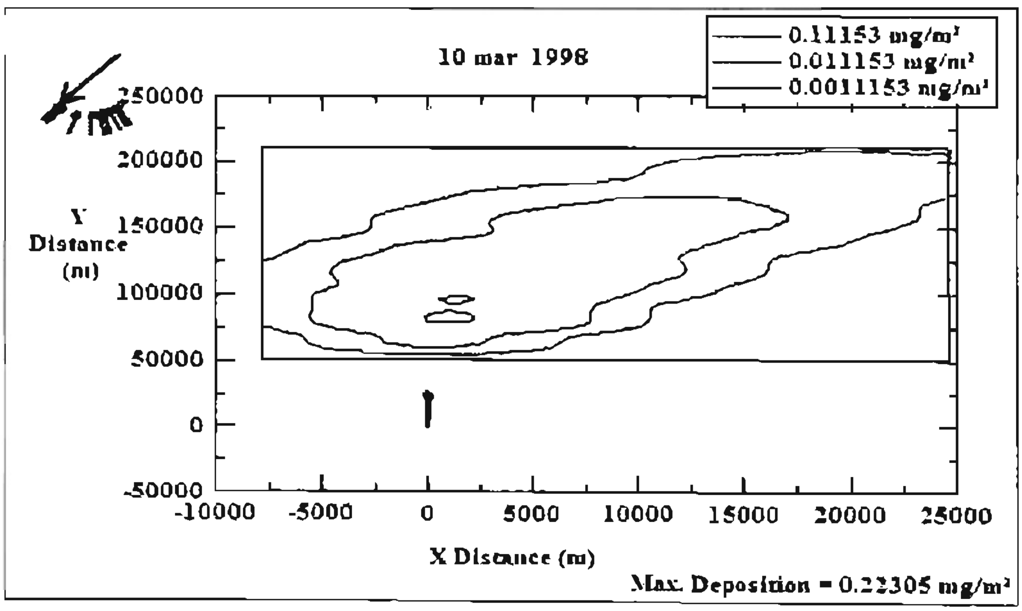


Figure 35: Deposition Isopleth Plot for the E-3A

The amount of fuel was decreased to 7,000 lbs for the E-3A in order to maintain the jettisoning route of 17-32 NM as shown in Figure 13 (c), Appendix H. It can be seen that isopleths are similar for all three aircraft, though maximum deposition vary with aircraft types. Comparisons of other output plots are shown in Figure 14- Figure 15, Appendix H.

Another interesting day was 12 December 2000. The ground level temperature was -8.5°C, and it was expected that more fuel would reach the ground, as the ground level temperature was low, as shown in Table 5, Appendix B. The model was run for the B-1B Lancer with the same input values used for previous examples as shown in Figure 16 (a), Appendix H.

Surprisingly, when the fuel was jettisoned form 20,000 feet AGL, hardly any fuel reached the ground, as shown in Figure 36. When the altitude was decreased and fuel was jettisoned from 5,000 feet AGL as shown in Figure 16 (b), Appendix H, almost 10%, i.e., 1200 lbs of the fuel reached the ground, as shown in Figure 37.

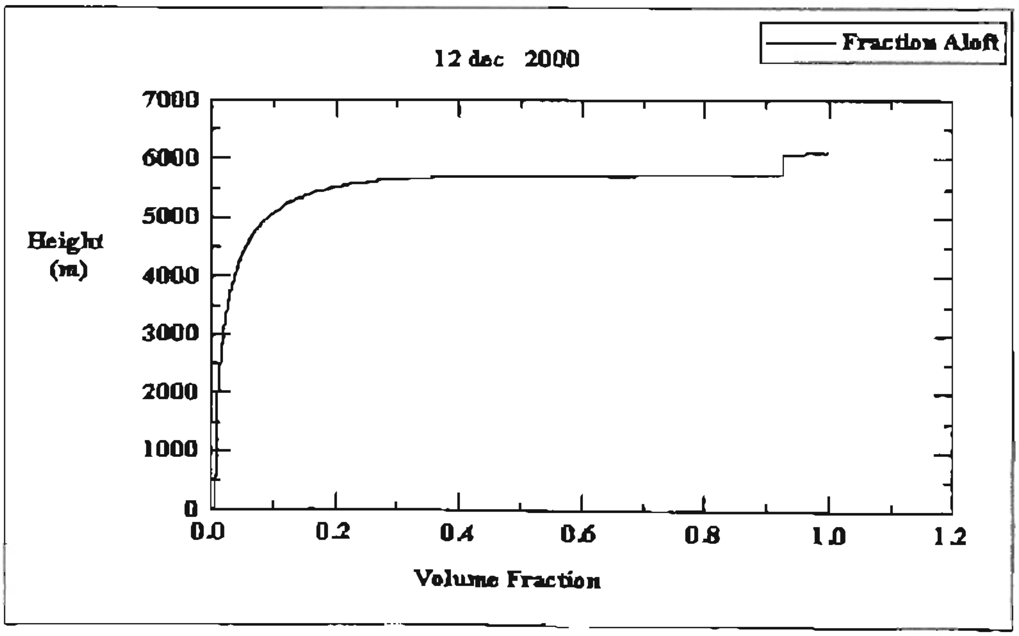


Figure 36: Plot of volume fraction aloft with height when the fuel was jettisoned from 20,000 feet AGL

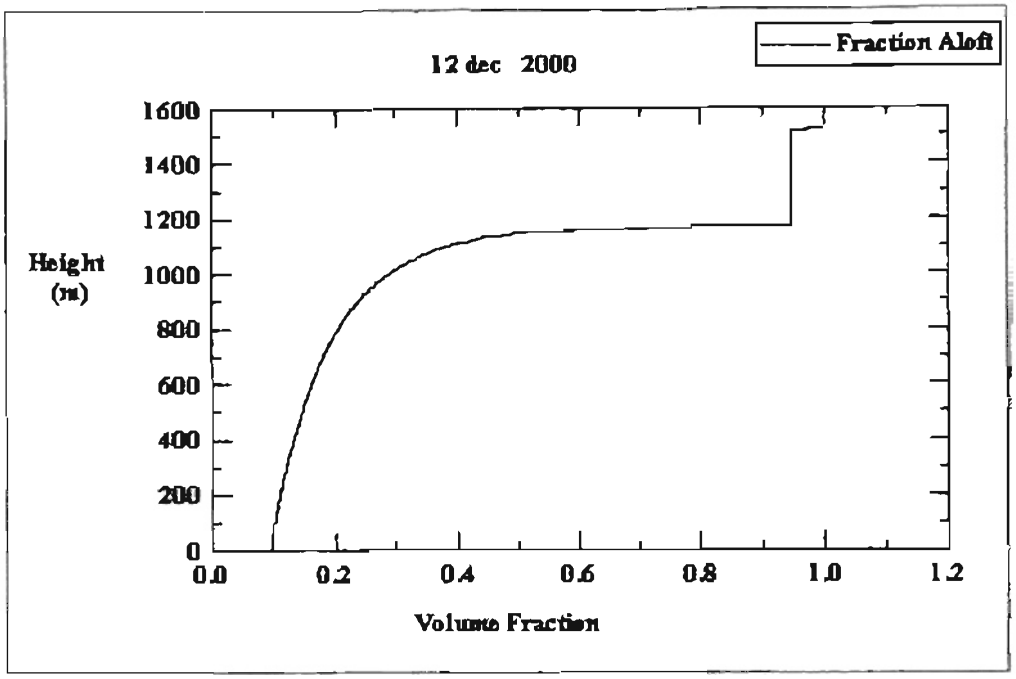
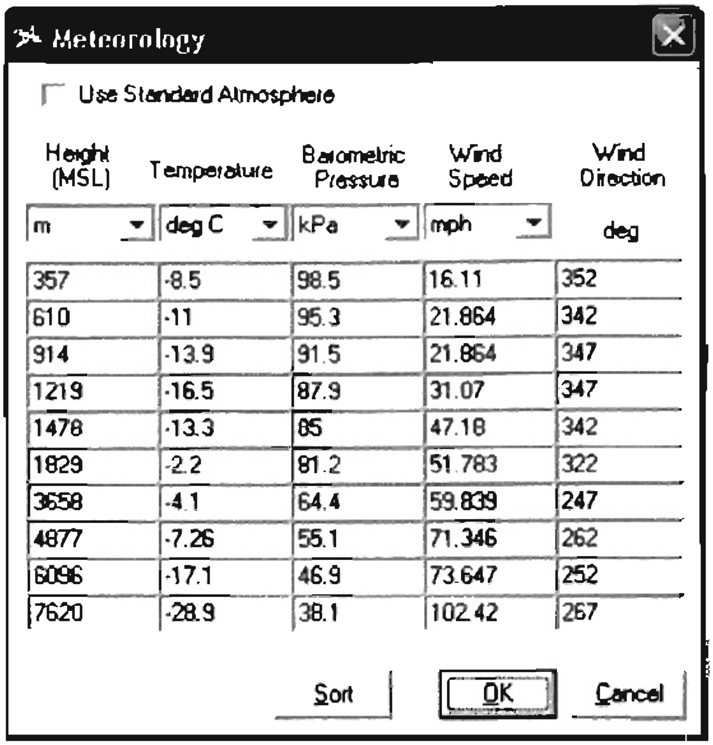


Figure 37: Plot of volume fraction aloft with height when the fuel was jettisoned from 5,000 feet AGL

The atmospheric soundings for this day are given in Table 5, Appendix B. The entries for the meteorological table of the FJSIM model are given in Figure 38. The reason for the discrepancies in volume fraction was although the temperature was very low in the ground level it started increasing from $-13.3^{o}C$ to $2.2^{o}C$ at 6,000 feet AGL. Above that altitude, the temperature started decreasing gradually, as can be seen in Figure 38.

This might be due to the temperature inversion experienced on this day. Usually the air closest to the ground is warmer, becoming cooler with increased distance from the surface of the ground. However, if cold air enters from outside an area, it may flow along the surface of the ground below the warmer air (EPA, 2003). The temperature inversion occurs when the colder air is not able to penetrate the warmer air. If the cooler air layer is polluted its pollution is also trapped within the temperature inversion until the layers begins to mix and the pollution can be dispersed (EPA, 2003)



Height (MSL)	Temperature	Barometric Pressure	Wind Speed	Wind Direction
m	deg C	kPa	mph	deg
357	-8.5	98.5	16.11	352
610	-11	95.3	21.864	342
914	-13.9	91.5	21.864	347
1219	-16.5	87.9	31.07	347
1478	-13.3	85	47.18	342
1829	-2.2	81.2	51.783	322
3658	-4.1	64.4	59.839	247
4877	-7.26	55.1	71.346	262
6096	-17.1	46.9	73.647	252
7620	-28.9	38.1	102.42	267

Figure 38: Meteorology of the FJSIM Model at OUN Norman, Oklahoma, on December 12, 2000

The temperature at 20,000 feet AGL was –17.1°C and at 5,000 feet AGL, -13.3°C. The simulated fuel was jettisoned from 20,000 feet AGL, the fuel started dropping down from 16,000 feet (5,000) m as can be seen in Figure 36. Temperature started increasing from –13.3°C at approximately 5,000 feet (1478m) AGL to –4.1°C at 12,000 feet (3658 m) AGL as can be seen in Figure 38. Figure 36 shows that the evaporation takes place when the fuel was dropping from approximately 16,000 feet (5000m) to 5,000 feet (1500m) after this simulated jettisoning event. At 5,000 feet (1500m), the volume fraction of the fuel was close to zero. Therefore, low temperature below 5,000 feet AGL had nothing to do with the evaporation of the fuel droplets from the simulated jettisoning event.

When the simulated fuel jettison took place at 5,000 feet AGL, the temperature was −13.3°C as can be seen in Figure 38. Since there was no temperature inversion at this altitude, and temperature was low, the percentage of the fuel reaching the ground was high from this simulated fuel jettisoning event. This example shows how temperature in the upper layers plays an important role in evaporation of jettisoned fuel. The isopleths plots shown in Figure 17(a) and Figure 17(b), Appendix H, at two different altitudes show that the maximum deposition was just 0.11489 mg/m^2 if the fuel was jettisoned from 20,000 feet AGL, while the maximum deposition is 3.6202 mg/m^2 if the fuel was jettisoned from 5,000 AGL.

The next set of exhibit shows the isopleth for a typical summer day. The day selected was August 1, 2001. The atmospheric sounding for that date is shown in Table 6, Appendix B. The sounding data show that the ground level temperature at 6:00 am CST on that date (5:00 am CDT) was 25 degrees Celsius (77 Fahrenheit). At 20,000 feet (6096m) AGL, the temperature was -5.2°C and wind speed was 10 kts. The input values and entries in meteorology on August 1, 2001 are shown in Figure 18 and Figure 19, Appendix H, respectively.

The isopleth for the simulated B-1B jettisoning event on August 1 2001 is shown in Figure 39. The maximum ground level deposition seen from this run is 0.0086715 mg/m^2, which is two orders of magnitude below the winter jettisoning event using the same aircraft operation inputs. The simulated plume was long as it spread until 500,000 meters in the north from the jettison area.

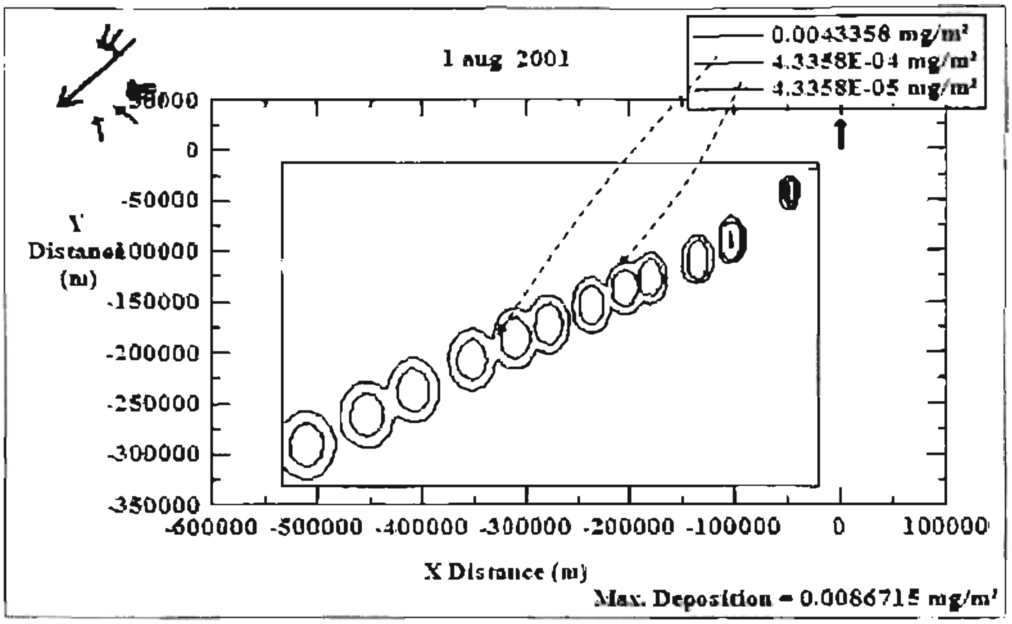


Figure 39: Isopleth of the B-1B jettison simulation for 1 August 2001

Figure 40, map from ArcView, shows that the simulated plume has exceeded north of Oklahoma border by 380,000 meters, as measured with the help of the "Measure" tool in ArcView, and reached Kansas. However, the deposition of the fuel jettisoned is very low; as the contour level deposition in simulated plumes ranges from 0.0043358 mg/m^2 to 4.3358E-05 mg/m^2 as can be seen in Figure 39.

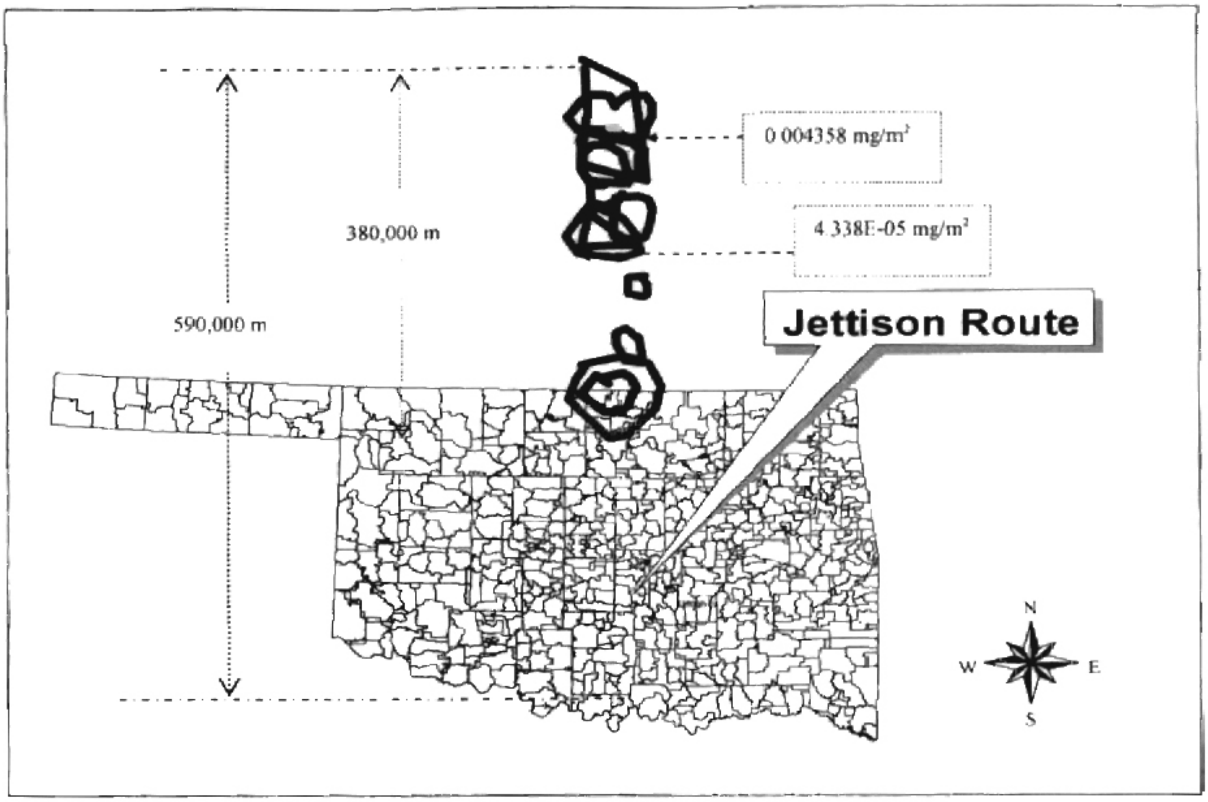


Figure 40: Distribution of the simulated plume due to fuel jettison on August 1, 2001

Another set of simulations was performed to compare the results with and without upper level meteorological data. The simulations were performed using meteorological data from December 15, 1998, reproduced in Table 7, Appendix B. A typical mid-December day, the 6:00 AM temperature was 1 degree Celsius (34 Fahrenheit) at the surface; winds were 4 kts from the south. This date was selected for this simulation because of the extreme variability in upper-level wind direction. The entries used for the meteorological table with and without upper level data are shown in Figure 20 (a) and Figure 20 (b), Appendix H respectively.

The isopleth for the B-1B jettison simulation using full meteorological data is shown in Figure 41.

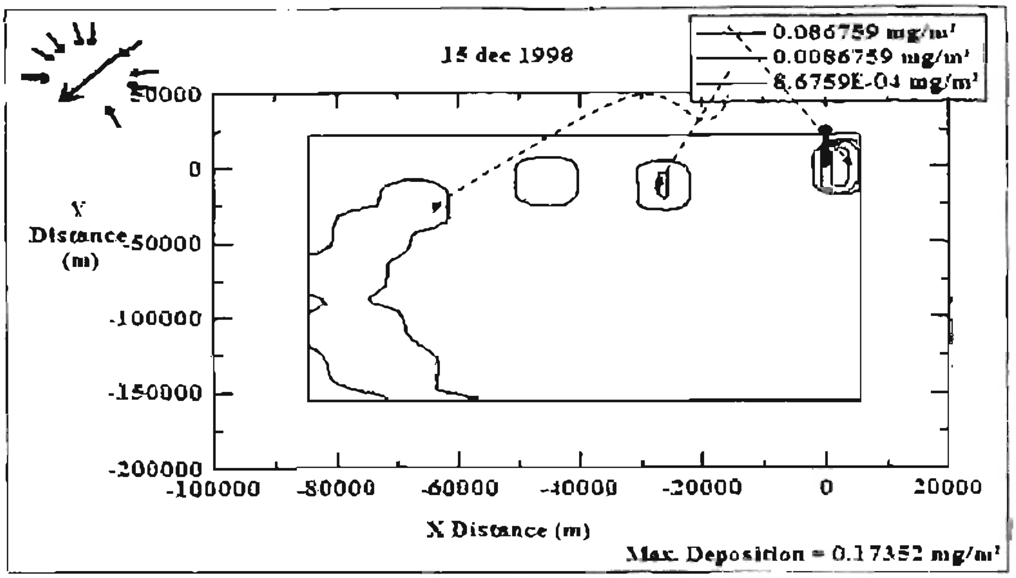


Figure 41: Isopleth of the B-1B jettison simulation for 15 December 1998, with meteorology defined at 10 altitude levels

When this isopleth plot was brought to ArcView, it could be seen in the case where meteorology was defined at 10 different altitude levels that most of the areas of the simulated plume was found in Pottawatomie County, as shown in Figure 42. Other affected counties from this simulation were Cleveland, Oklahoma, Lincoln, Payne, Logan, Kingfisher, Garfield and Major. The deposition on the contour at these counties was comparatively low, i.e., 8.67-04 mg/m^2 as can be seen in Figure 41. However, the contour level deposition in Pottawatomie and partly in Cleveland County was 0.00807 mg/m^2. The maximum deposition on the contour was in Pottawatomie County, i.e., 0.0867 mg/m^2, as can be seen in Figure 42. Those counties in Oklahoma that were affected by the simulated fuel jettison on this day are shown in Figure 43.

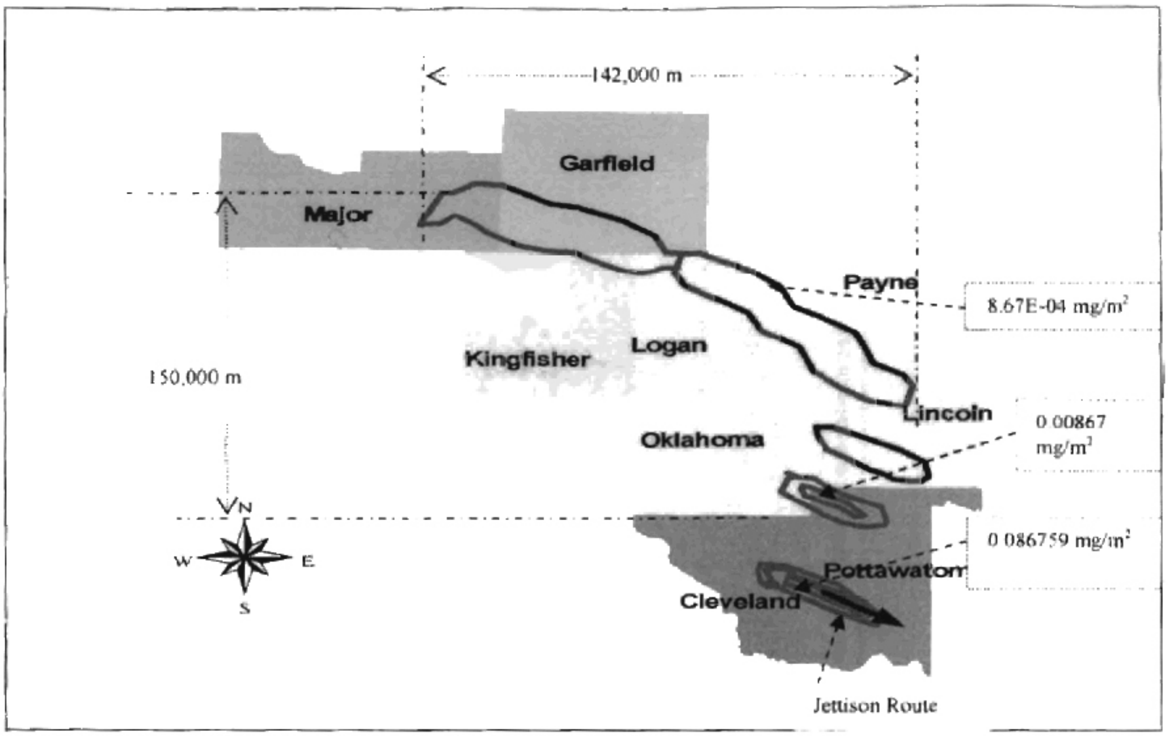


Figure 42: Distribution of the simulated plume due to fuel jettison on December 15, 1998, with meteorology defined at 10 altitude levels

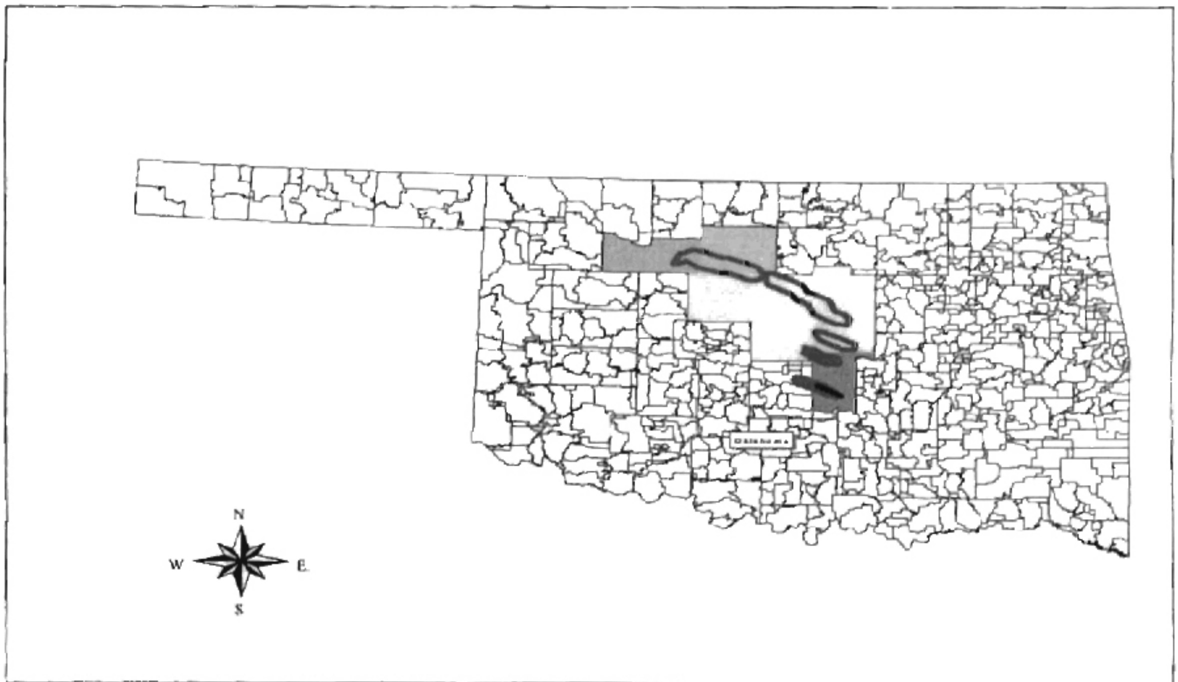


Figure 43: Simulated affected counties in Oklahoma on December 15, 1998

Figure 44 shows the isopleth when only the surface meteorological data are used. It can be seen that both the maximum ground level depositions and the locations of simulated groundfall vary greatly between these two simulations shown when Figure 45 is compared to Figure 42.

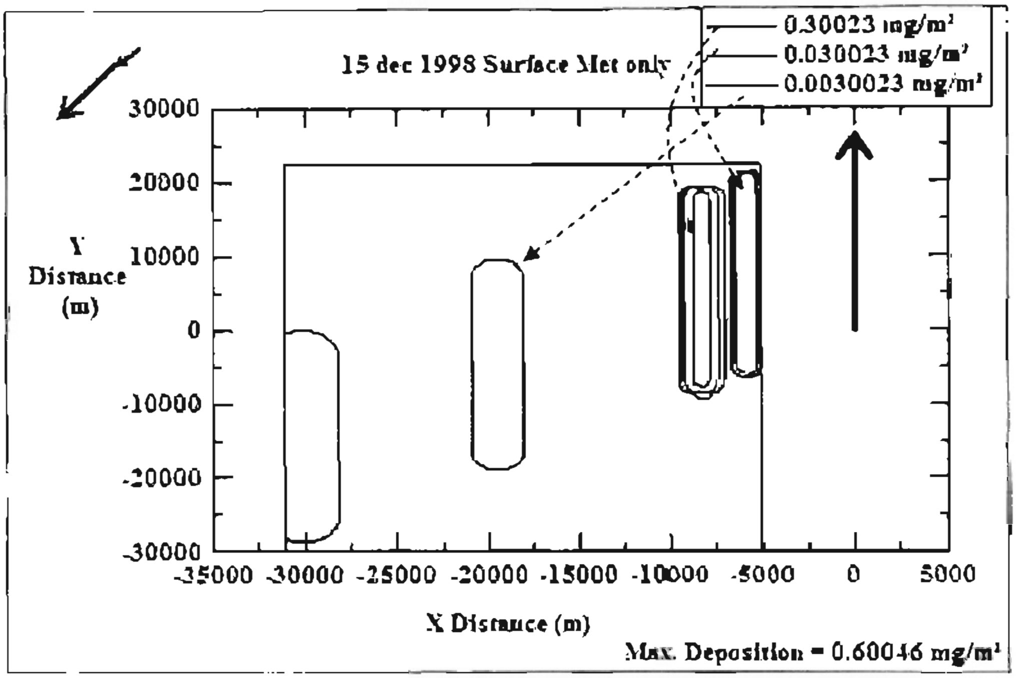


Figure 44: Isopleth of the B-1B jettison simulation for 15 December1998, using only surface-level meteorological data

Unlike before, affected counties from this simulation were Pottawatomie and Oklahoma only as can be seen in Figure 46. The maximum deposition was 0.60046 mg/m^2. The contour level deposition in these counties ranged from 0.30023 mg/m^2 to 0.0030023 mg/m^2. Therefore, these runs show how important upper level meteorological data are in order to get the better predicted location of the plume.

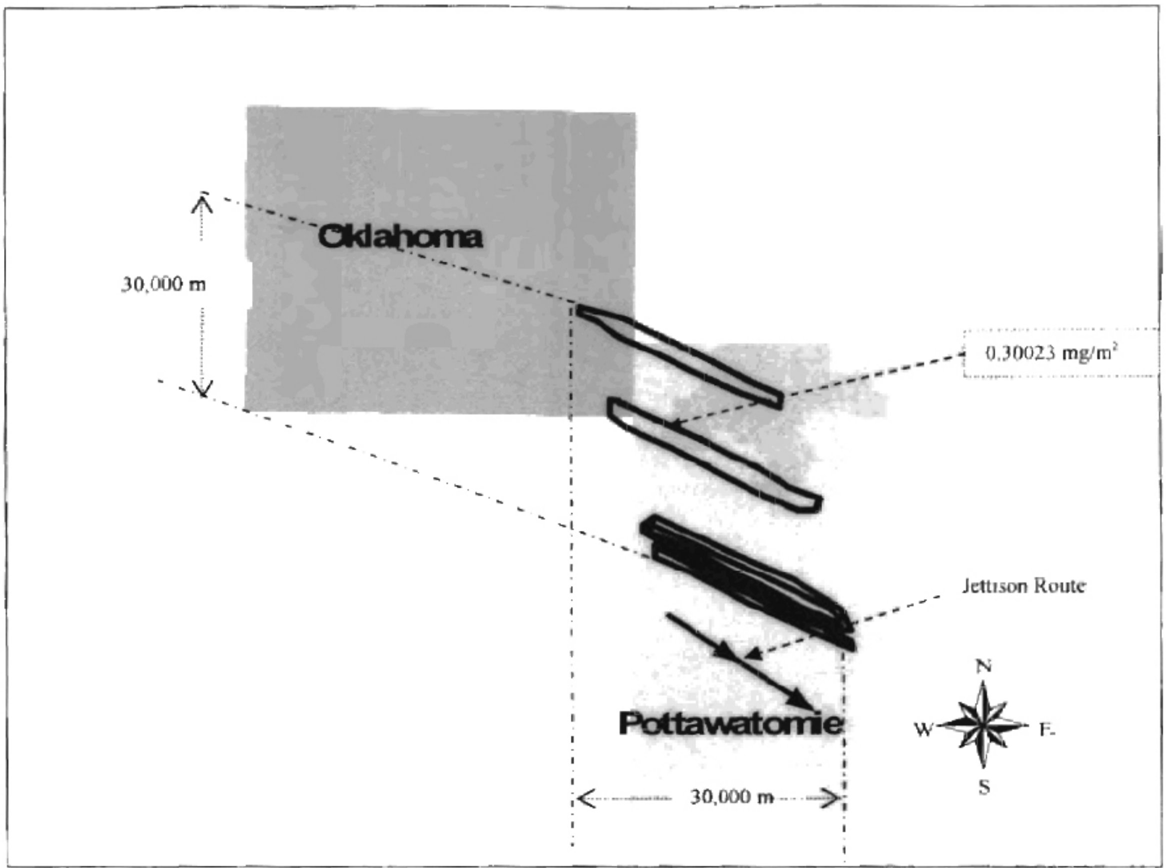


Figure 45: Distribution of the simulated plume on December 15, 1998, using only surface-level meteorological data

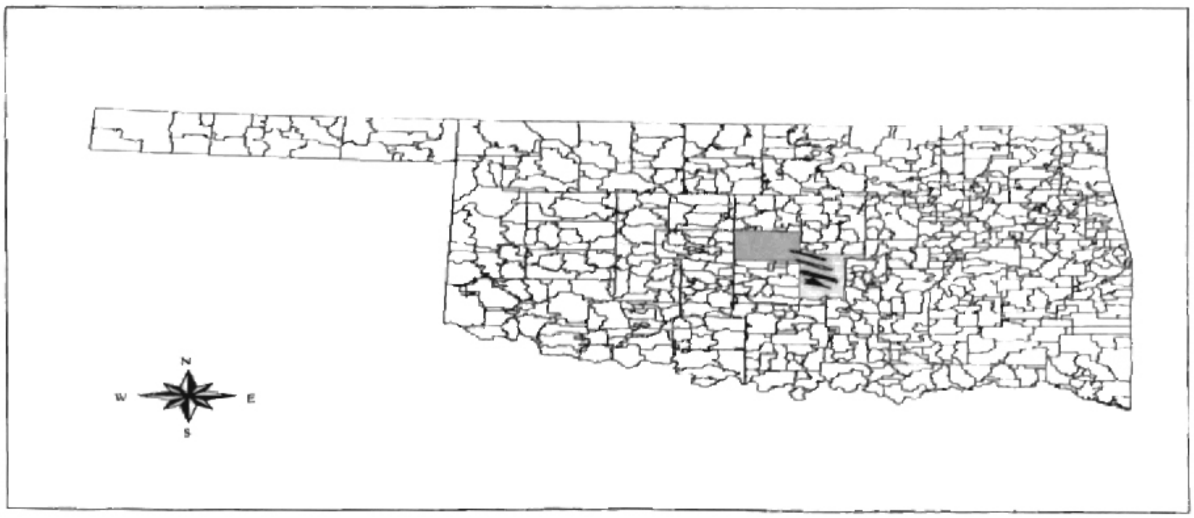


Figure 46: Simulated affected counties in Oklahoma on December 15, 1998, using only surface-level meteorological data

The next set of simulations shows the impact of jettisoning procedure conducted at low altitude on the maximum ground level deposition and its location. A pair of simulations was conducted to determine the difference between a 20,000 ft AGL jettison event and 5,000 ft AGL jettison event with all other input held constant. Figure 47 shows an isopleth with the jettisoning conducted at 20,000 ft AGL.

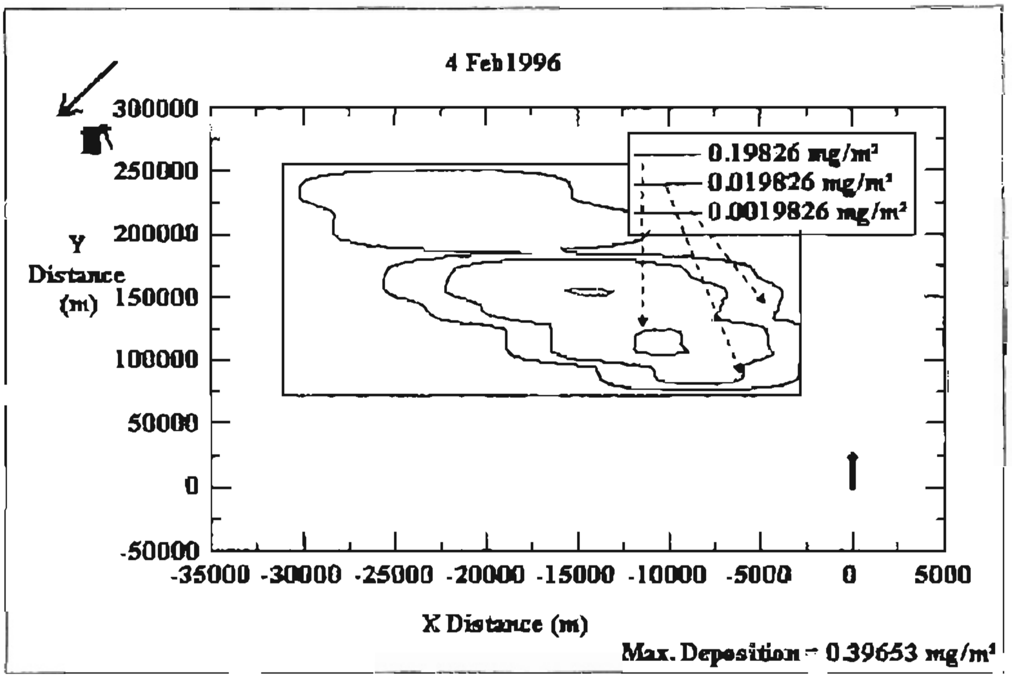


Figure 47: Isopleth of the B-1B jettison simulation for 4 February 1996, jettisoning conducted at 20000 ft AGL

Figure 48 shows the isopleth plot for the same aircraft, all parameters the same except for the jettisoning altitude being reduced to 5000 ft AGL. It can be seen that the maximum deposition was 16.172 mg/m^2, as compared to 0.39653 mg/m^2 when the fuel was jettisoned from 20,000 feet AGL.

The location of the zone of maximum ground level deposition was approximately 1500 meters east of the end of the jettison run, as compared to 10,000 to 15,000 meters southeast of jettison area for the high-altitude simulation.

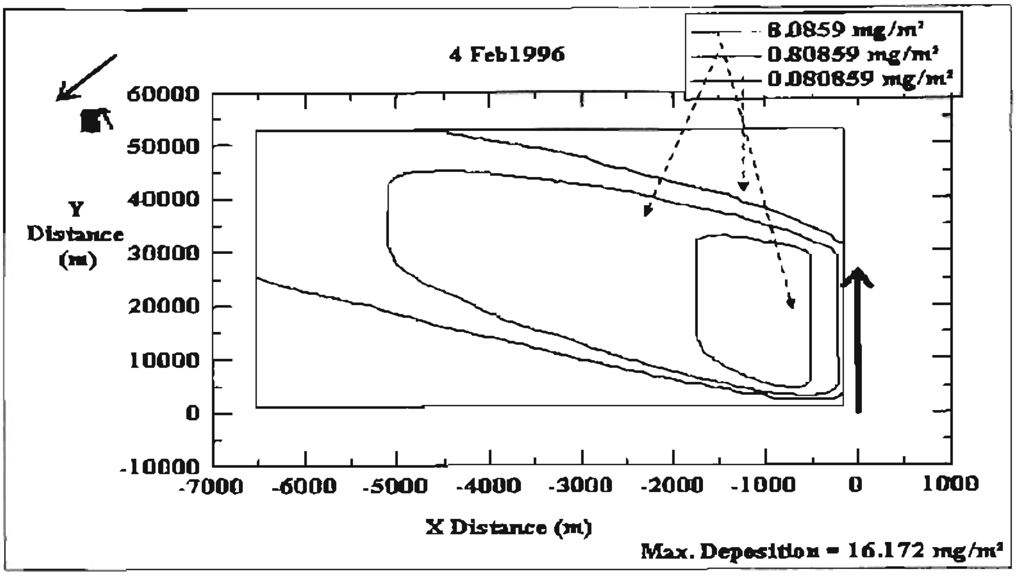


Figure 48: Isopleth of the B-1B jettison simulation for 4 February1996. jettisoning conducted at 5000 ft AGL

This finding was expected, since the lower altitude of jettisoning does not allow time for dispersion of the fuel, thus, the maximum deposition is higher and closer to the source of the fuel (the jettisoning aircraft) as can be seen in Figure 49. The simulated affected counties were Pottawatomie and Seminole only as can be seen in Figure 50. The maximum deposition was 16.72 mg/m^2 in these counties. Thus, a low-level jettisoning event by a heavy aircraft could present an environmental impact, if the event occurred during a period of cold weather and minimal winds.

Figure 51 shows the simulated affected counties when the fuel was jettisoned from 20,000 feet AGL. Higher altitudes of jettisoning allowed time for dispersion of the fuel, and thus, the simulated plume has moved almost 70,000 meters southeast of the Pottawatomie County. The simulated affected counties are Pittsburgh, Atoka, Pushmataha, Coal, Hughes and McCurtain as can be seen in Figure 52.

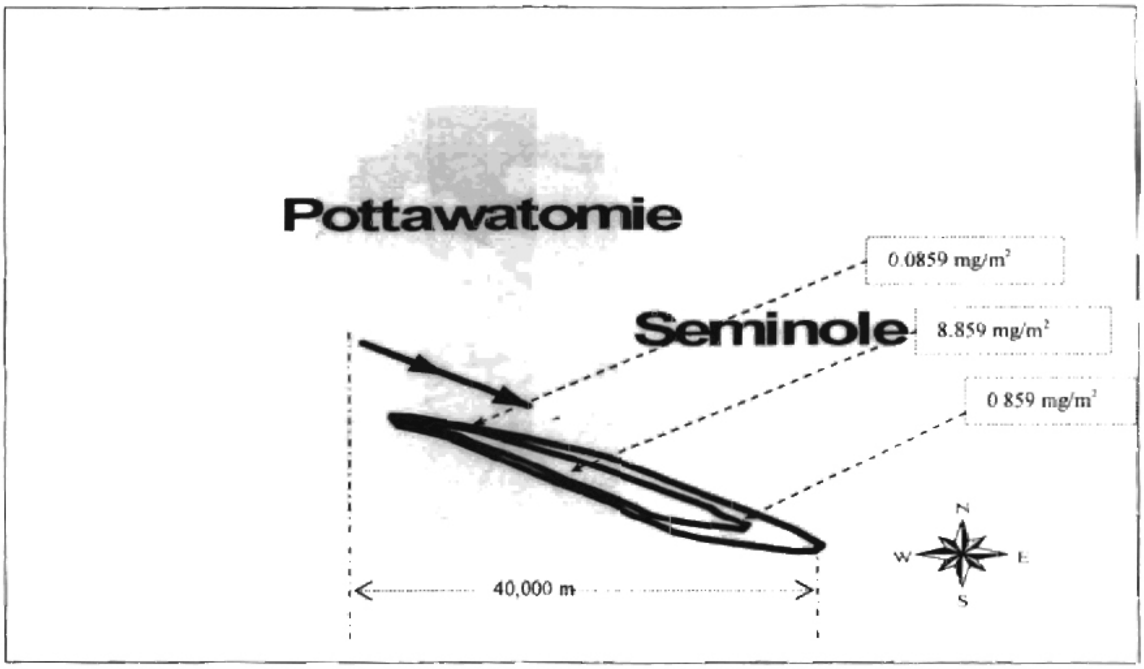


Figure 49: Distribution of the simulated plume when the fuel was jettisoned from 5,000 feet AGL on February 4, 1996

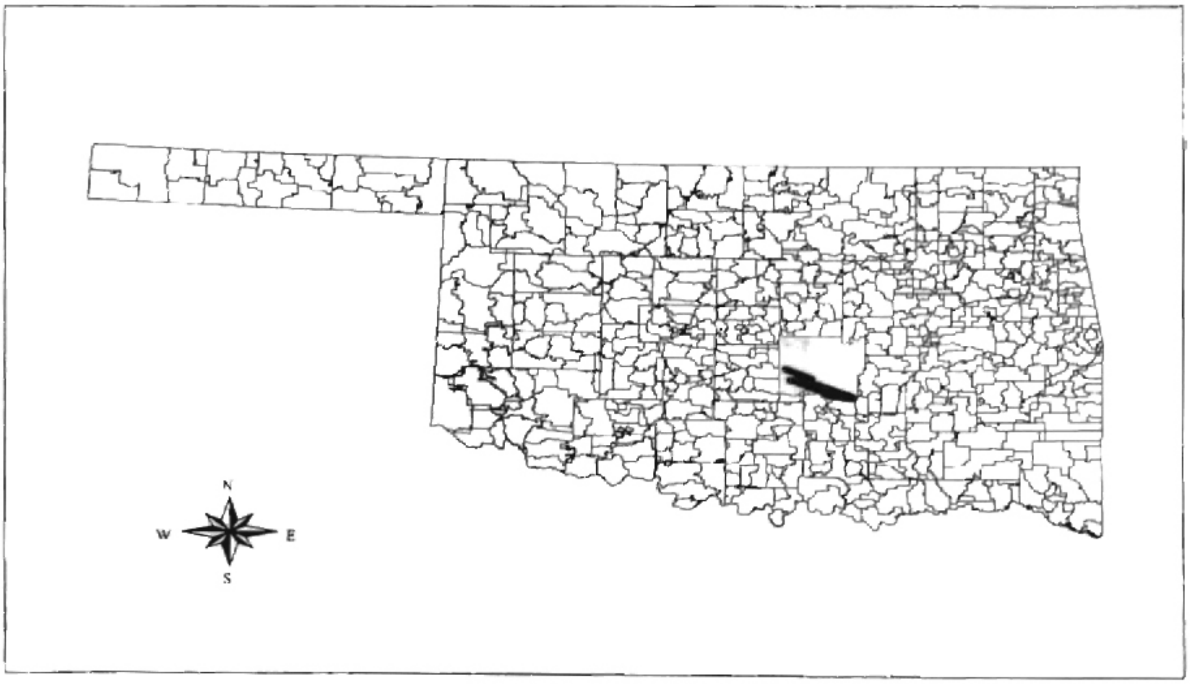


Figure 50: Affected simulated counties when the fuel was jettisoned from 5,000 feet AGL

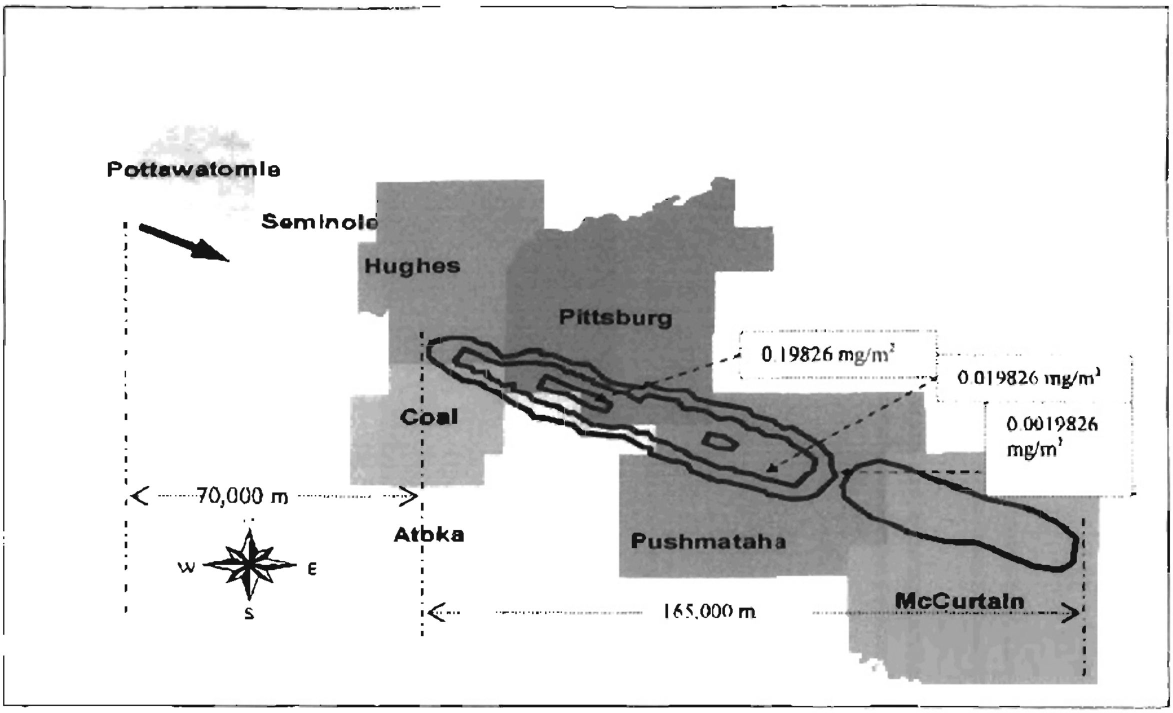


Figure 51: Distribution of the simulated plume when the fuel was jettisoned from 20,000 feet AGL on February 4, 1996

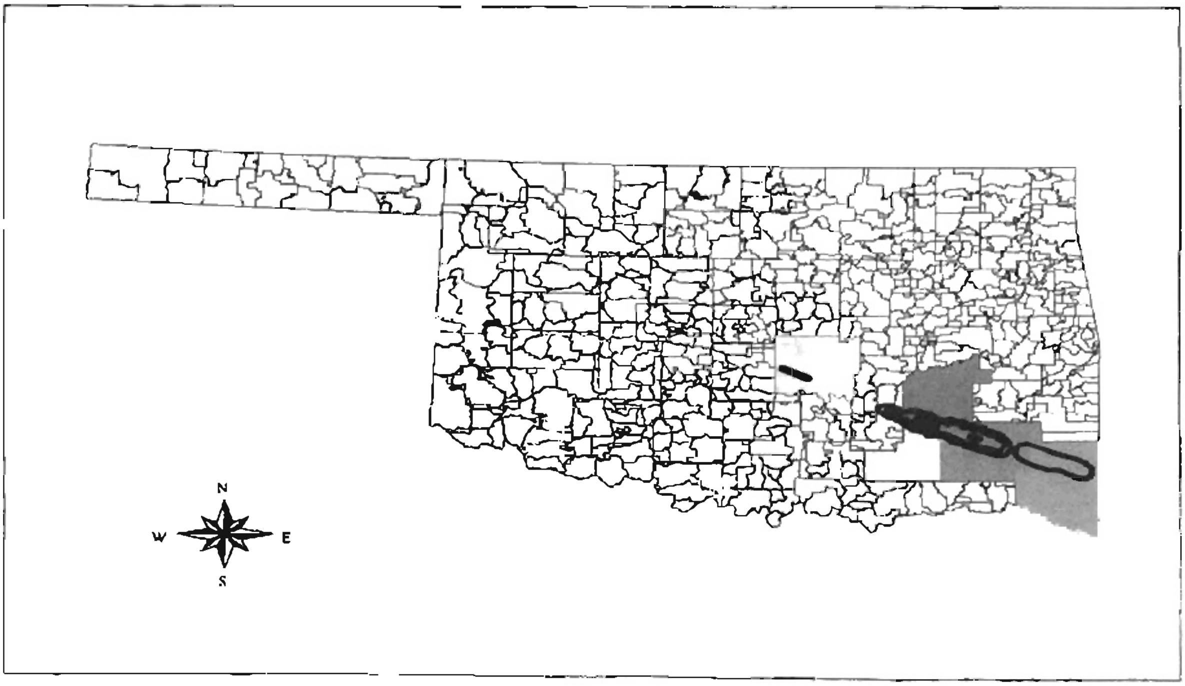


Figure 52: Affected simulated counties when the fuel was jettisoned from 20,000 feet AGL

The next set of exhibits show the difference in plume shape and maximum ground level deposition for different upper air meteorology. Two close days were chosen, i.e., April 29, 1999, and May 1, 1999. The operating conditions were the same on both days as can be seen in Figure 21(a) and Figure 21(b), Appendix H. The ground level temperature on May 1 was slightly more (by 1°C) and surface winds are slightly less on this day compared to April 29, as can be seen in Figure 22 (a) and Figure 22 (b), Appendix H. The impact of the stronger and more consistent upper level winds with altitudes is evident when Figure 53, isopleth for the E-3A on May 1 is compared to Figure 55, isopleth for the same aircraft on April 29, 1999. The winds had taken the plume to the northwest side of Oklahoma on May 1, 1999, as can be seen in Figure 55. It should be noted that the simulated plume has exceeded the northwestern side of Oklahoma and has reached Colorado as can be seen in Figure 54. However, the maximum deposition on May 1, 1999 is an order lower than that of April 29, 1999.

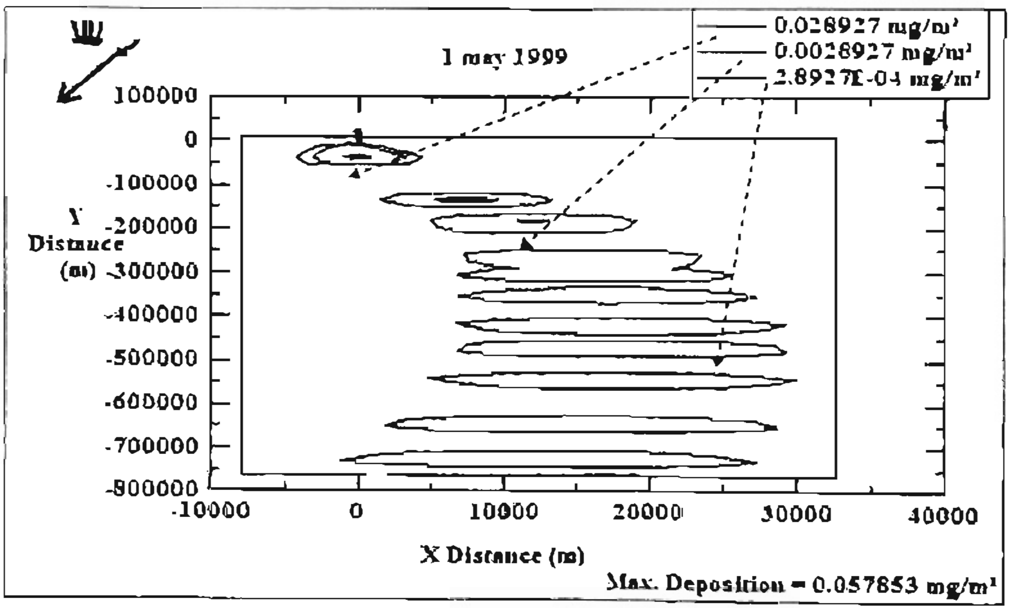


Figure 53: Deposition isopleth plot for the E-3A on 1 May, 1999

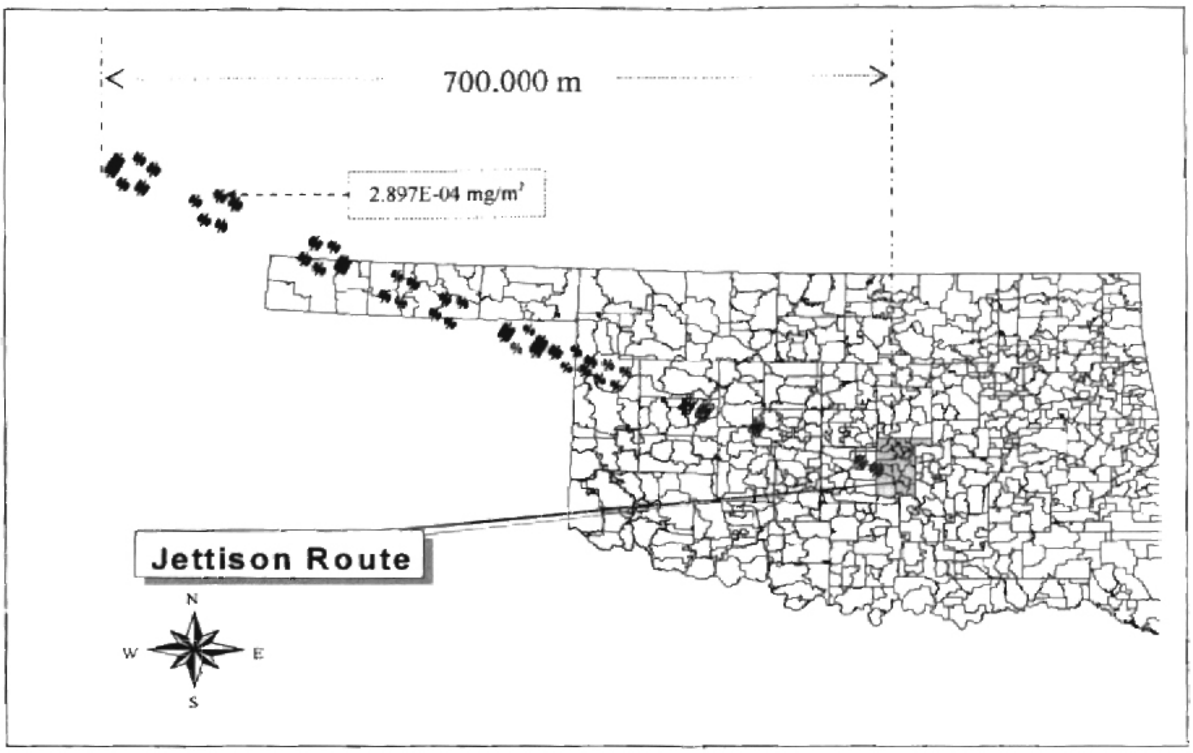


Figure 54: Distribution of the simulated plume on May 1, 1999

On April 29, 1999, with the same operating conditions for the same aircraft, the affected area is 200,000 meters southwest of the jettison area, as can be seen in Figure 55.

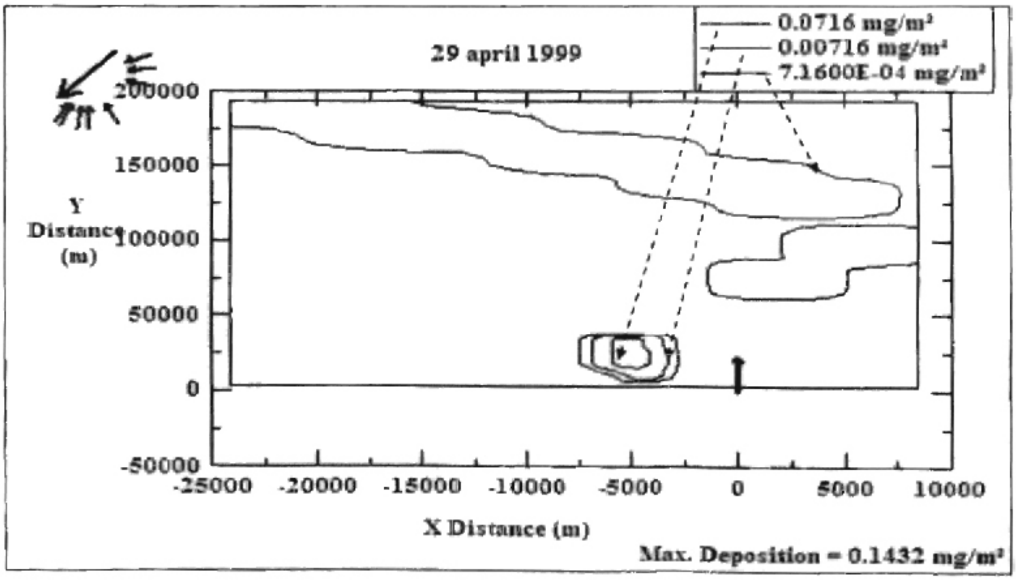


Figure 55: Isopleth plot for the E-3A on April 29, 1999

The simulated plume in Figure 56 shows that the most affected counties were Pottawatomie and Seminole Counties, where the deposition of the fuel in the contour ranged from 0.0716 mg/m^2 to 0.00716 mg/m^2. Other affected counties from this simulated jettison event were Coal, Pittsburgh, Atoka, Pushmataha and Hughes as can be seen in Figure 57. However, the contour level deposition of the simulated fuel in these counties was comparatively less, i.e., 7.16E-04 as can be seen in Figure 56. The maximum ground level deposition on May 1, 1999, is 0.05783 mg/m^2, which is much lower than April 29, i.e., 0.1432 mg/m^2. However, area of the simulated plume is thrice as far from the jettison route on May 1, 1999, as compared to April 29, 1999. This is because that winds act to disperse the jettisoned fuel droplets, so that higher winds reduce the maximum ground level deposition. Figure 57 shows the simulated affected counties in Oklahoma when the fuel was jettisoned from 20,000 feet AGL on April 29 1999.

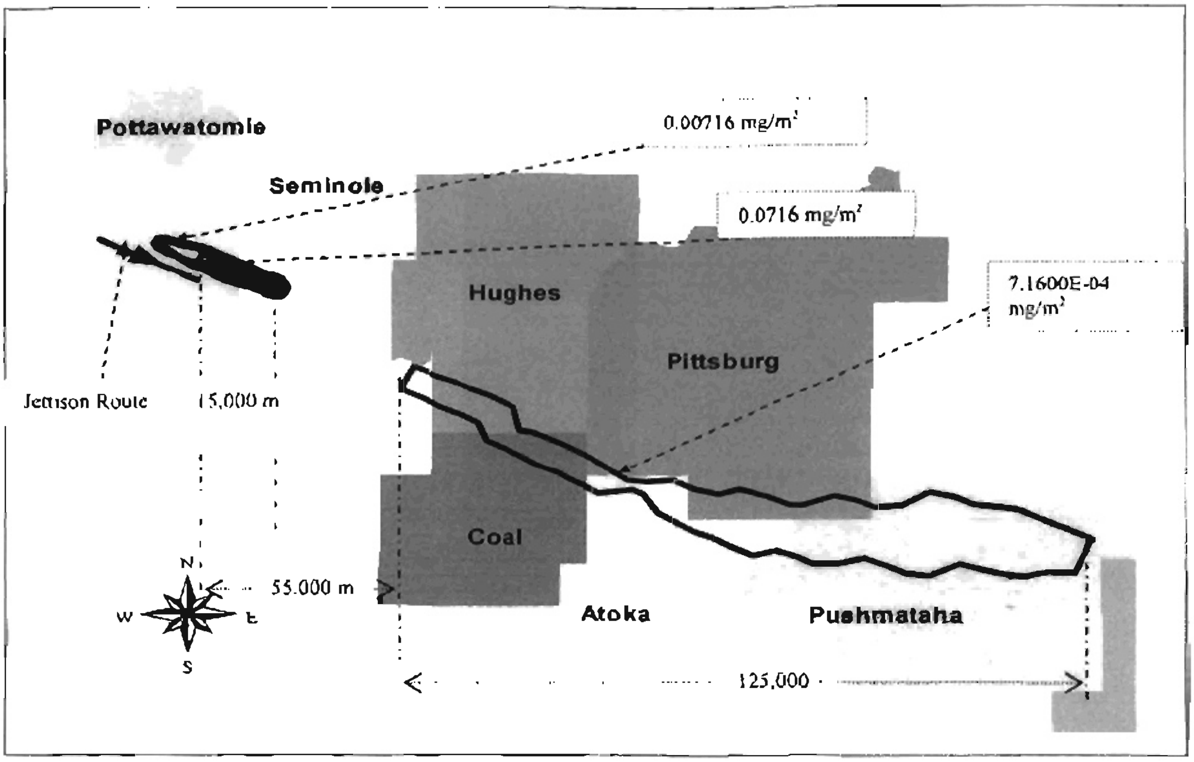


Figure 56: Distribution of the simulated plume due to jettison on April 29, 1999

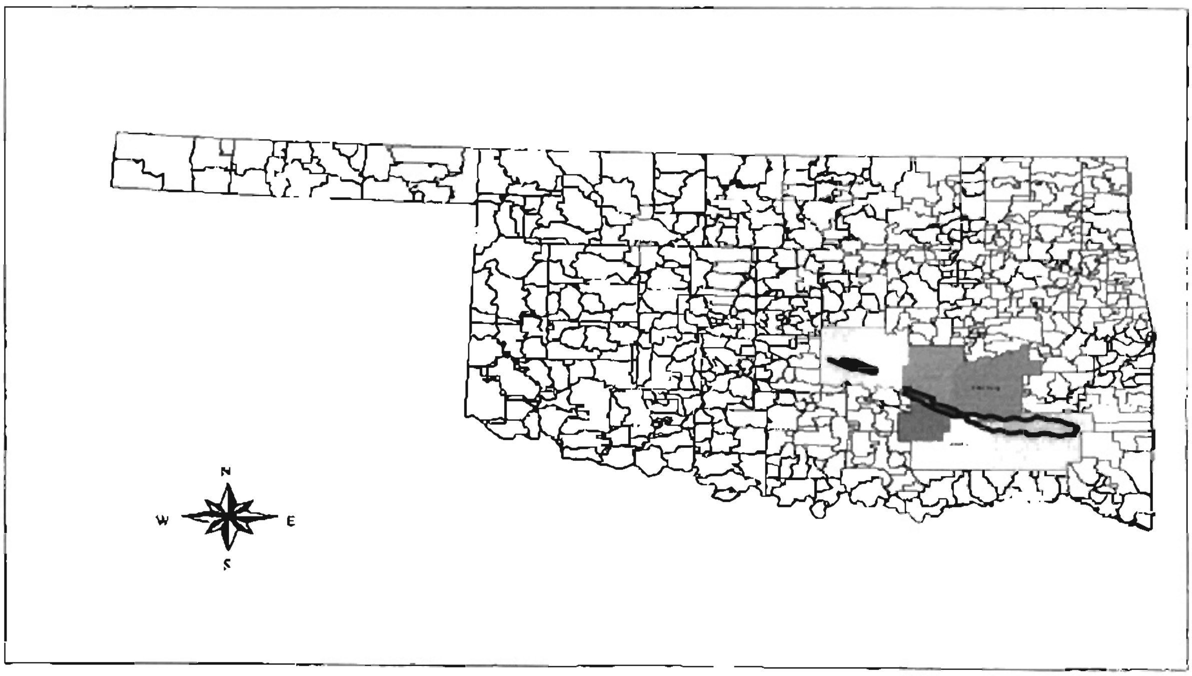


Figure 57: Affected simulated counties due to jettison on April 29, 1999

The next set of exhibits show the interesting role of wind direction in the shape of the plume. The day chosen is September 12, 1996. It was a moderately hot day with ground temperature 23.5°C, and winds at different altitudes were coming from both east and west direction of the jettison route as can be seen in Figure 23, Appendix H. The isopleth plot shown in Figure 58 is the evidence of inconsistency in upper level wind direction. This plot shows that the area of the simulated plume is spread on both northeast and northwest of the jettison area as can be seen in Figure 58.

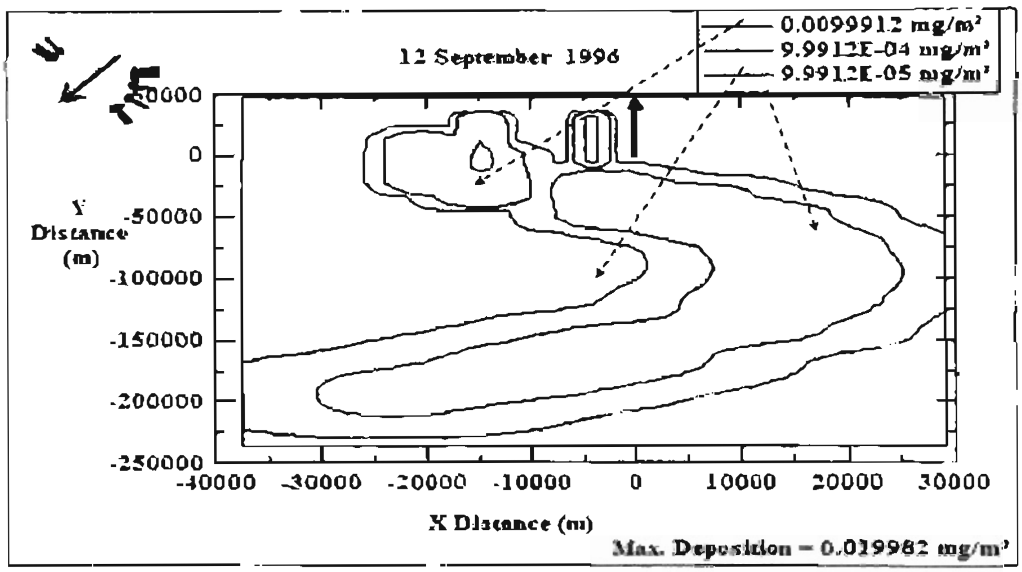


Figure 58: Isopleth Plot for the E-3A on September 12, 1996

Figure 59 below shows the affected counties by the simulated fuel jettison on this day. The contour of 1/2th of the maximum deposition, i.e., 0.09912 mg/m^2, is in Pottawatomie and Cleveland Counties. In other simulated affected counties, the contours of the simulated plume had fuel deposition ranging from 9.99E-04 mg/m^2 to 9.99E-05 mg/m^2, as can be seen in Figure 59. Other affected counties from this simulation apart from Pottawatomie and Cleveland were Woodward, Custer, Major, Caddo, Dewey, Blaine, Canadian, Grady, Oklahoma, McClain, and Seminole as can be seen in Figure 59. Figure 60 shows the large part of Central Oklahoma covered by this simulated plume.

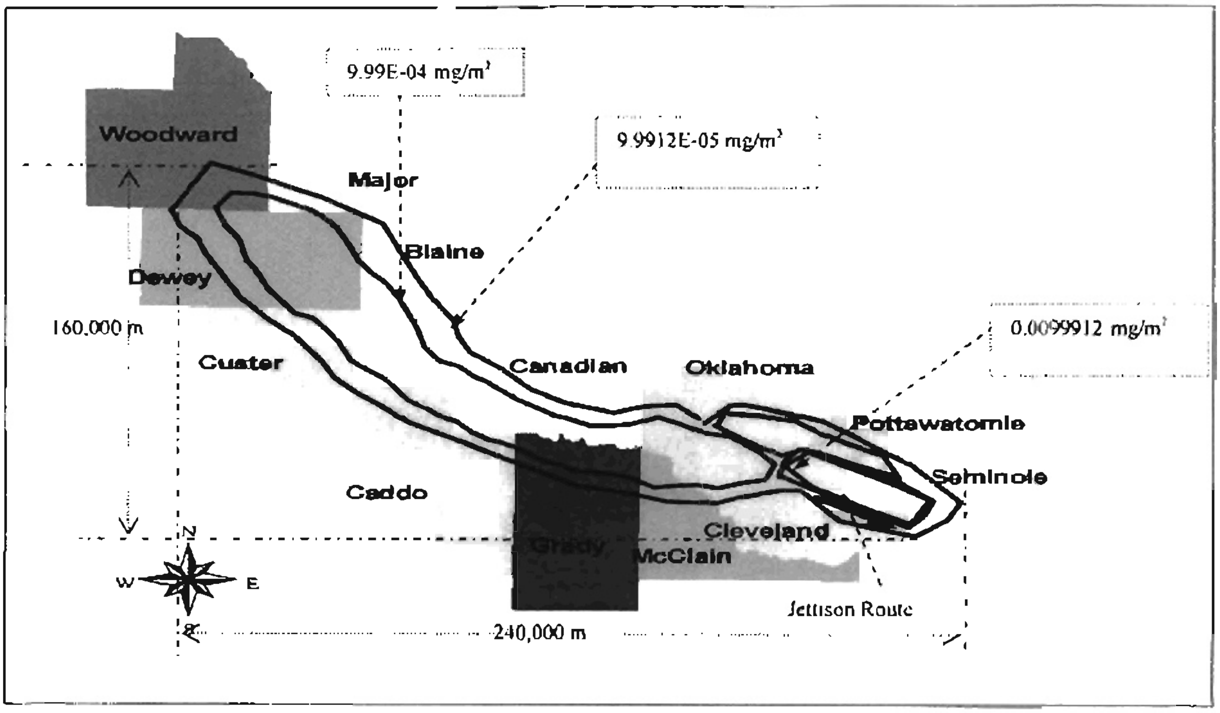


Figure 59: Distribution of the simulated plume due to jettison on September 12, 1996

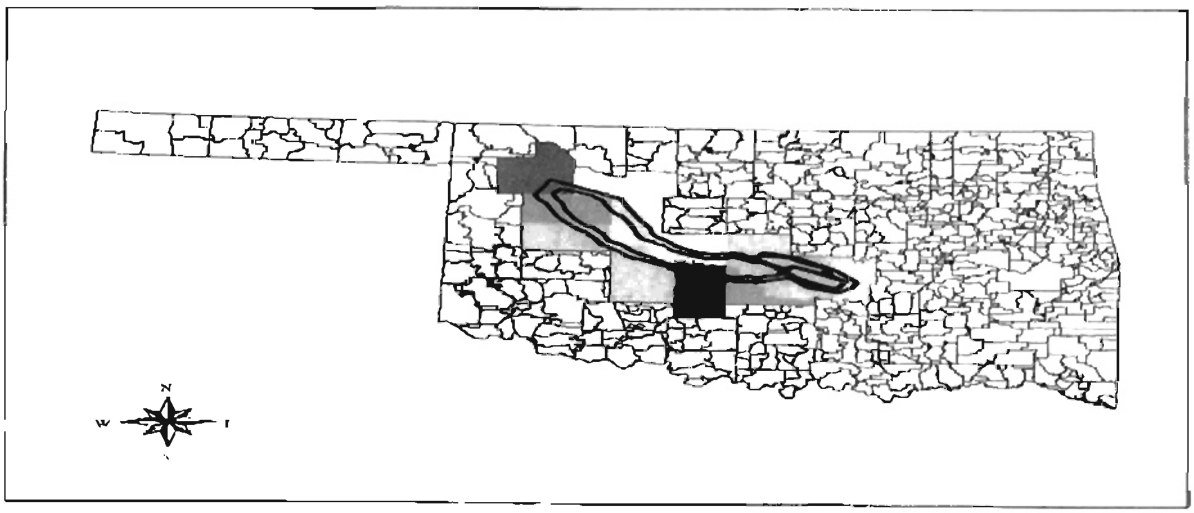


Figure 60: Simulated affected counties in Oklahoma State on September 12, 1996

In order to see what happen if the winds were coming from the same direction at ten different altitudes considered, actual data were modified by increasing the degree of wind directions coming from the east at three different altitudes by 180 degree. All other meteorological data and operating conditions were unchanged, as can be seen in Figure 24(a) and Figure 24(b), Appendix H. This made upper level wind directions at ten different altitudes coming from the same direction as can be seen in Figure 61. The result of the consistent wind directions with altitudes is evidence in Figure 62, where the plume the length of the plume was longer than the one shown in Figure 61.

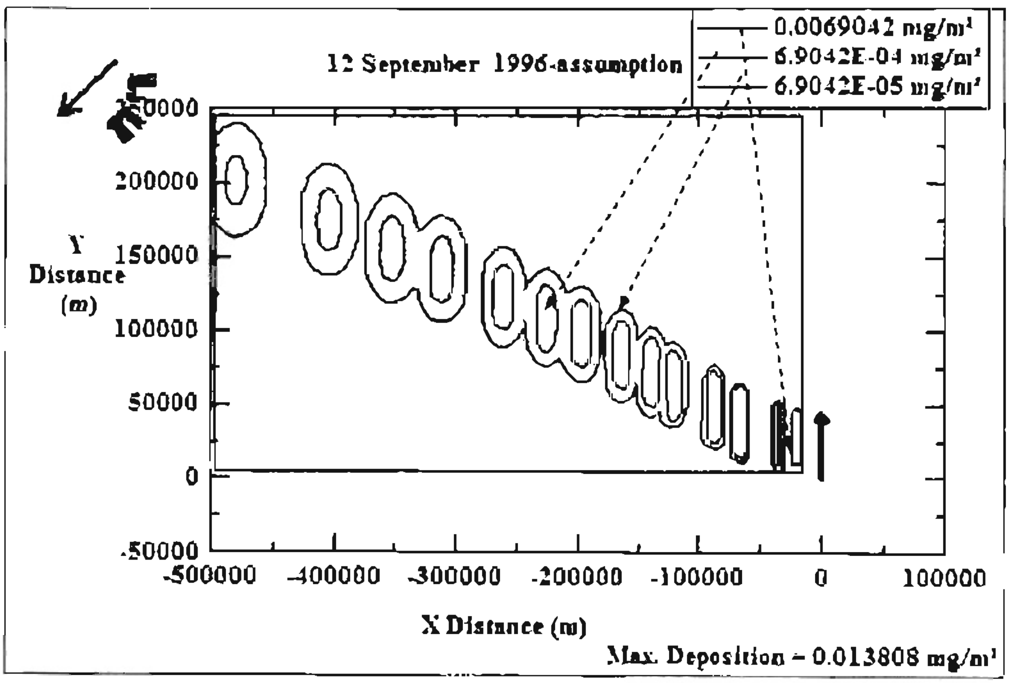


Figure 61: Assumption isopleth plot for the E-3A on September 12, 1996

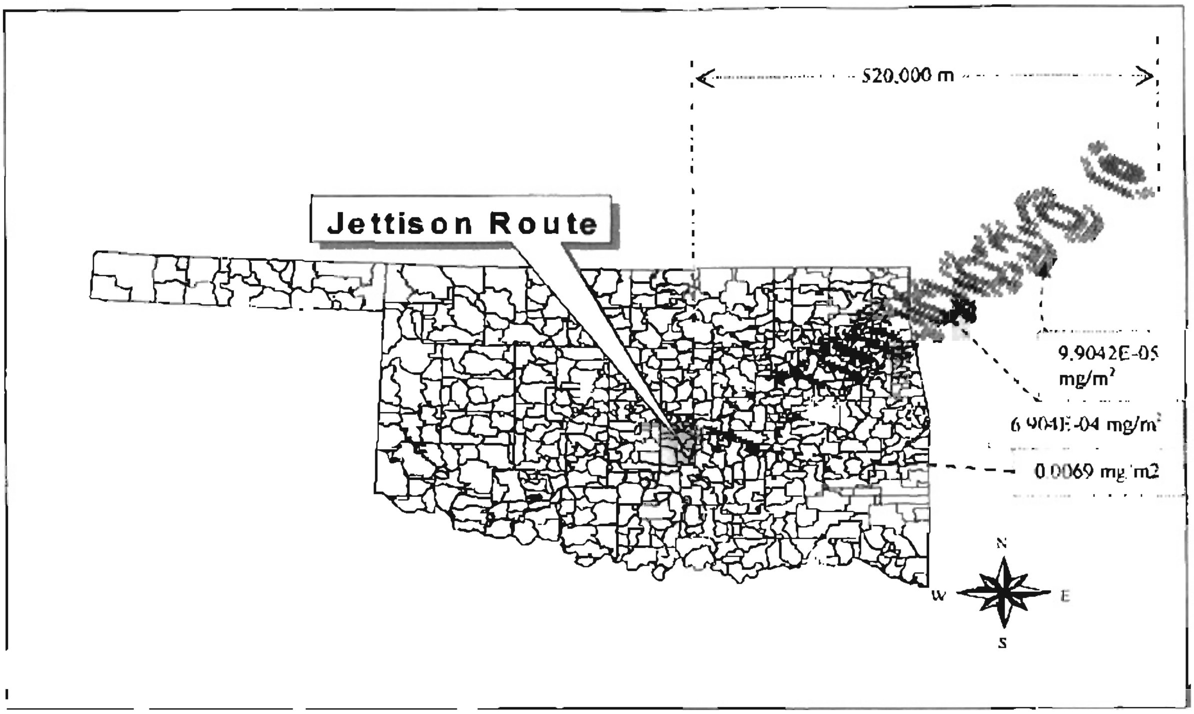


Figure 62: Distribution of the simulated plume on September 12, 1996

The simulated plume has crossed the northeast border of Oklahoma and reached Missouri and Arkansas. This result was expected as the winds disperse the plume, and as, winds at all altitudes were coming from the same direction, winds were comparatively stronger in this case than the previous. It needs to be noticed that the maximum deposition decreased slightly when the winds at ten different altitudes were coming from the same direction.

Another set of example show the difference in the result in the isopleth plots when the winds are coming from north-south directions and east-west directions at ten different altitudes. On March 13, 1999, winds were coming from North-South directions as can be seen in Figure 25(a), Appendix H. The isopleth plot on this day is shown in Figure 63, in which the plume starts right from the jettison area. In order to see the result if the winds were coming from east-west directions on this day, we increased the degrees of wind directions by 90 degrees at ten different altitudes, keeping all other data unchanged, as can be seen in Figure 25(b) and Figure 26, Appendix H. This new isopleth plot shown in Figure 64, shows that the simulated plume starts spreading from almost 10,000 meters south of the jettison area.

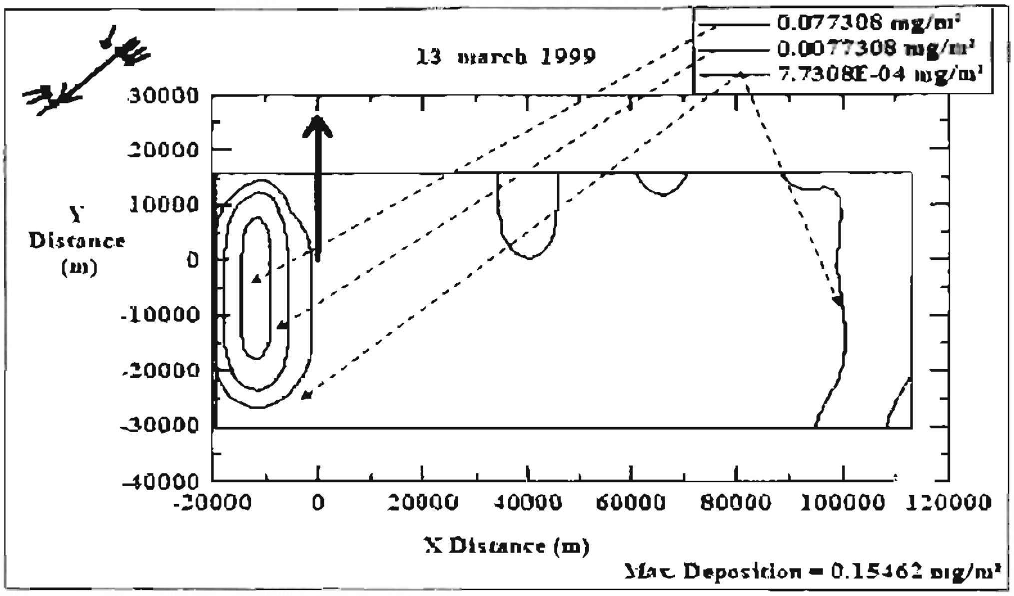


Figure 63: Isopleth plot for the E-3A on March 13, 1999

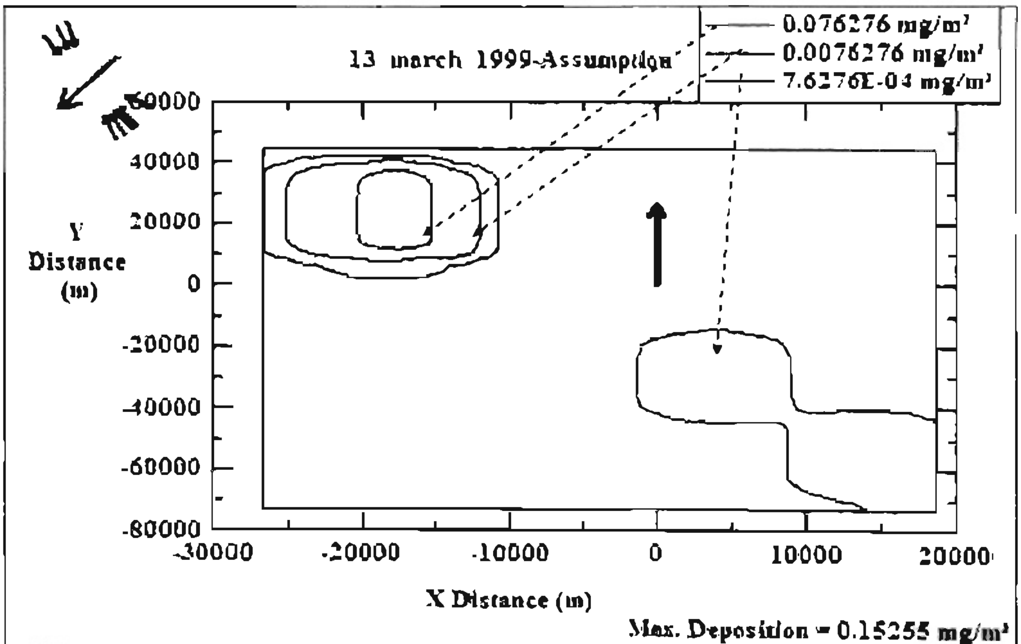


Figure 64: Assumption isopleth plot for the E-3A on March 13, 1999

It needs to be noticed that there was not much difference in the maximum depositions in both the cases.

The GIS based maps in Figure 65 and Figure 67 show that in the former case, the affected simulated areas were in Pottawatomie County and the counties that were located in south of Pottawatomie County. In the latter case also, Pottawatomie County was affected. However, Seminole County, which is located in east of Pottawatomie County and Cleveland, McClain and Grady which are located in west of Pottawatomie County were affected. Figure 66 and Figure 68 show the affected counties in these two simulated jettisoning events discussed above. It can be seen that the areas covered by the simulated plumes in these two cases are almost similar, though in different locations. Interestingly, there is not much difference in the maximum deposition in these counties.

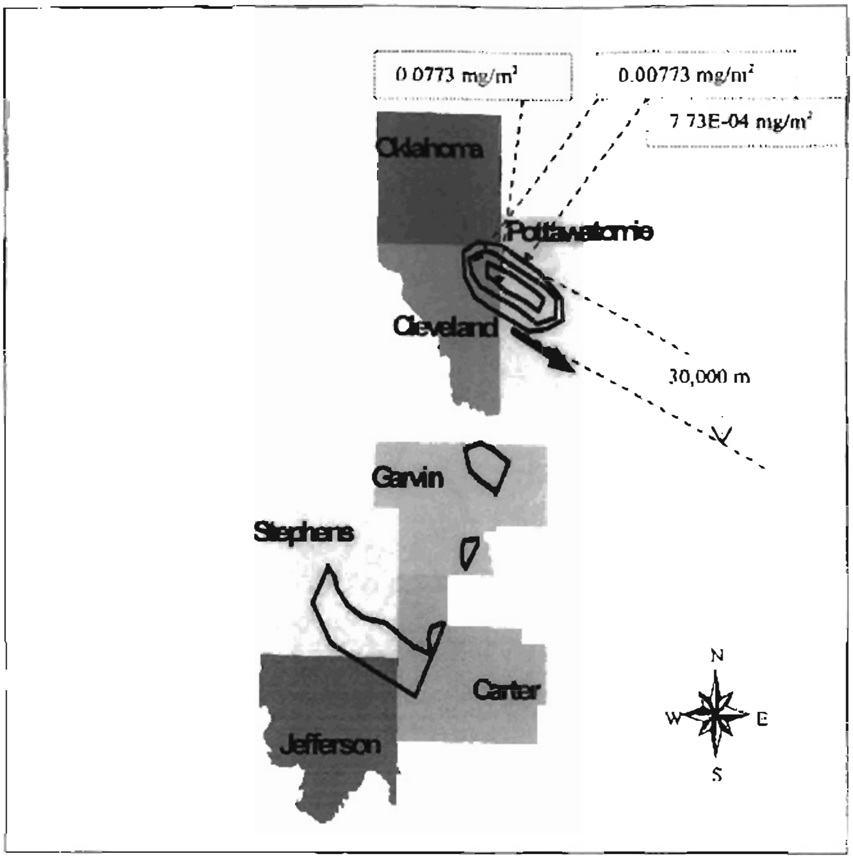


Figure 65: Distribution of the simulated plume on March 13, 1999

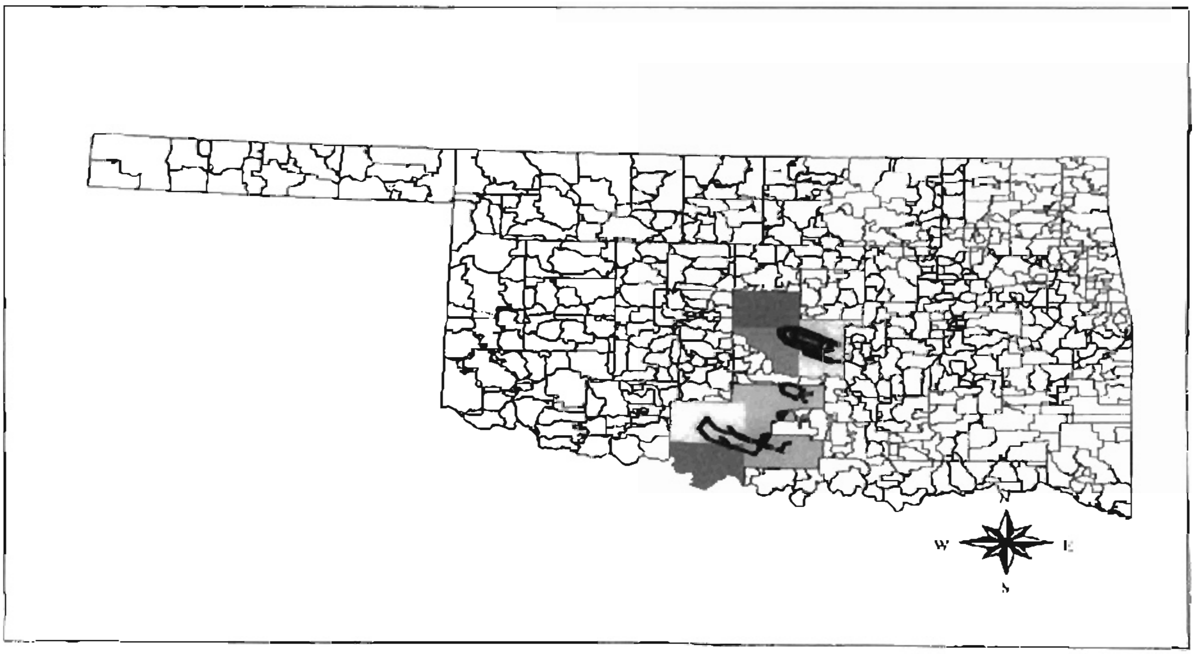


Figure 66: Simulated affected counties in Oklahoma State on March 13, 1999

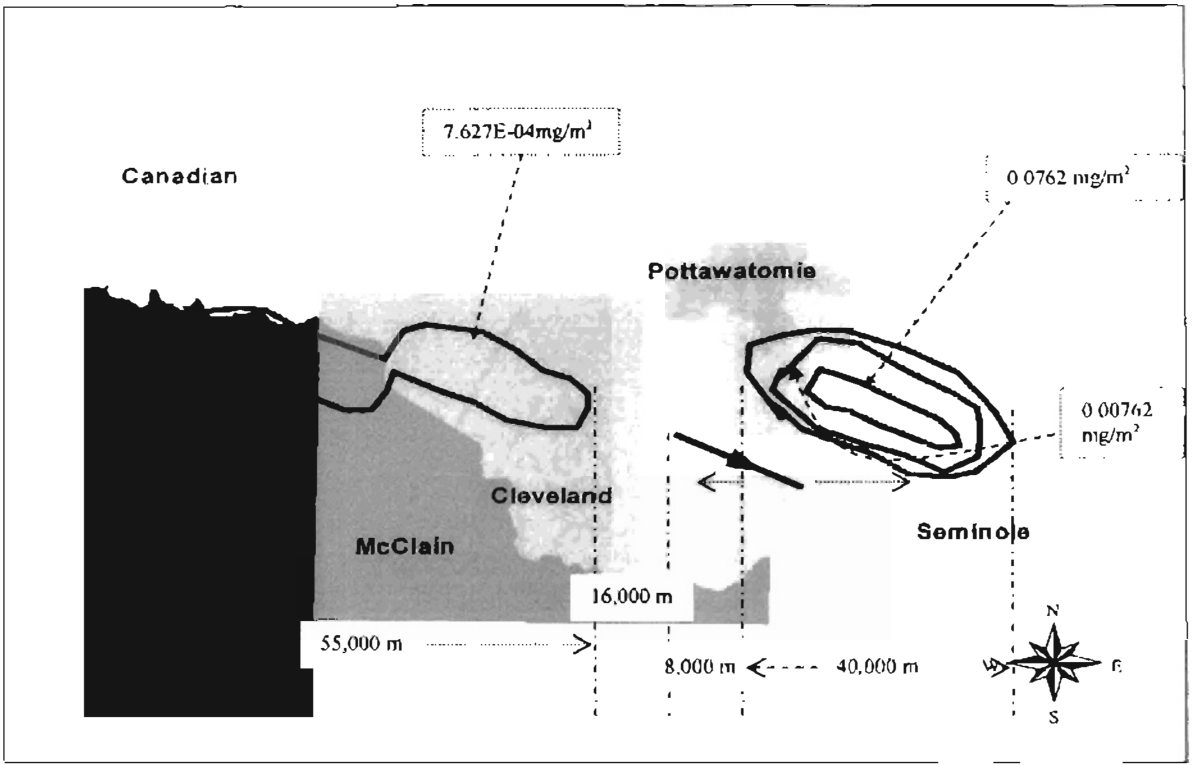


Figure 67: Distribution of the assumed simulated plume on March 13, 1999

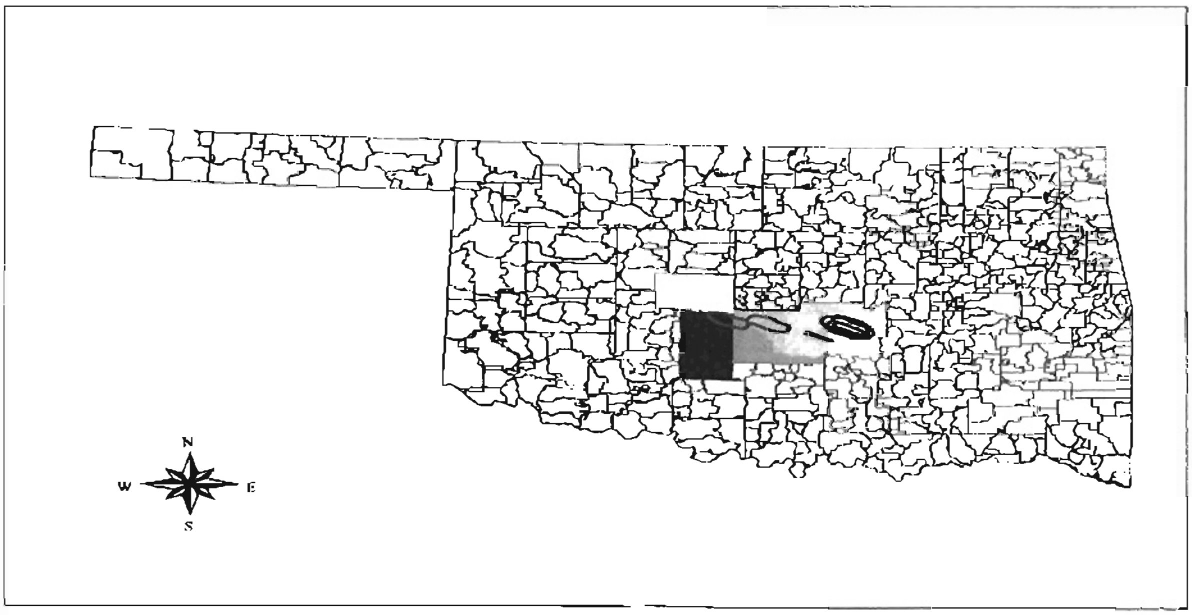


Figure 68: Simulated affected Counties on March 13, 1999

6.2 Sensitivity analysis

A systematic procedure to determine the sensitivity of the outcomes to change in input parameters is called sensitivity analysis. If small changes in a parameter result in relatively large changes in the outcome, then the outcome is said to be sensitive to that parameter. "A sensitivity study should be considered whenever an actual jettisoning event is being modeled" (Teske et al., 2000). The FJSIM run requires many parameters, and the numerical results can be highly sensitive to small changes in any parameter value. This may mean that the parameter must be determined very accurately. Therefore, it is important to recognize the most significant parameters and the amount of variability likely to be encountered in these parameters.

A Tinker AFB-specific sensitivity analysis of the FJSIM model was performed using the aircraft systems and average conditions at Tinker AFB. This analysis gives a good picture of which parameters are important in predicting the severity of a jettisoning event. The parameters varied in the sensitivity analysis were:

1. Air speed
2. Wind speed
3. Ground level temperature
4. Ground level pressure
5. Jettisoning altitude
6. Aircraft type
7. Fuel type
8. Wind direction

Except for parameters being varied, all runs used the following parameters,

Aircraft speed	=	200 mph
Pressure	=	976 mbar
Jettison altitude	=	20,000 feet
Wind speed	=	14 mph
Wind direction	=	180 degrees (true) at ground level
Temperature	=	0 degrees at ground level
Fuel jettisoned	=	10,000 lbs
Fuel type	=	JP-8

Standard atmosphere assumed

The sensitivity analyses were done for all three aircraft. Summaries for the sensitivity analyses of the KC-135, the B-1B Lancer, and the E-3A Boeing are given in Table 14, Table 15, and Table 16 respectively.

TABLE 14:

THE FJSIM SENSITIVITY ANALYSIS FOR THE KC-135

Run number	Aircraft's speed, mph	Maximum deposition (ml/m^2)	Percentage of fuel reaching the ground
A-1	200	0.01783	25
A-2	250	0.00647	17
A-3	300	0.00288	6
A-4	350	0.0012	3
A-5	400	0.000796	1.5
Run number	Wind speed (G.L), mph	Maximum deposition (ml/m^2)	Percentage of fuel reaching the ground
B-1	2.3	0.1024	25
B-2	10	0.0248	25
B-3	20	0.0125	25
B-4	30	0.00849	25
B-5	40	0.00642	25
Run number	Temp (G.L) ^{o}C	Maximum deposition (ml/m^2)	Percentage of fuel reaching the ground
C-1	-20	0.0207	10
C-2	-10	0.0197	18
C-3	0	0.0178	20
C-4	10	0.01383	33
C-5	20	0.00936	35
Run number	Pressure, mBar	Maximum deposition (ml/m^2)	Percentage of fuel reaching the ground
D-1	970	0.0178	25
D-2	980	0.0179	25
D-3	990	0.0179	25
D-4	1000	0.018	25
Run number	Altitude, meters	Maximum deposition (ml/m^2)	Percentage of fuel reaching the ground
E-1	2000	0.0646	34
E-2	3000	0.04	30
E-3	4000	0.0289	28
E-4	5000	0.0224	26
E-5	6000	0.0182	25

Run number	Aircraft type	Maximum deposition (ml/m^2)	
F-1	KC-135	0.00351	
F-2	E-3A	0.00159	
F-3	B-1B	0.00539	

Run number	Fuel type	Maximum deposition (ml/m^2)	Percentage of fuel reaching the ground
G-1	JP-8	0.0178	25
G-2	JP-4	0.00498	7
G-3	JP-8/JP-4 (50/50 mix)	0.00931	11

Run number	Wind direction	Maximum deposition (ml/m^2)	Percentage of fuel reaching the ground
H-1	0	0.0181	25
H-2	45	0.0143	25
H-3	90	0.0182	25
H-4	135	0.12838	25
H-5	180	0.01783	25
H-6	225	0.0144	25
H-7	270	0.0185	25
H-8	315	0.13316	25

TABLE 15:

THE FJSIM SENSITIVITY ANALYSIS FOR THE B-1B

Run number	Air speed, mph	Maximum deposition (ml/m^2)	Percentage of fuel reaching the ground
A-1	200	0.014624	23
A-2	250	0.0053883	10
A-3	300	0.0023495	5
A-4	350	9.46E-04	2
A-5	400	7.33E-04	1

Run number	Wind speed (G.L), mph	Maximum deposition (ml/m^2)	Percentage of fuel reaching the ground
B-1	2.3	0.081197	22
B-2	10	0.020308	24
B-3	20	0.010353	23
B-4	30	0.0069783	23
B-5	40	0.00525	23

Run number	Temp (G.L) °C	Maximum deposition (ml/m^2)	Percentage of fuel reaching the ground
C1	-20	0.017409	10
C2	-10	0.016414	16
C3	0	0.014624	24
C4	10	0.01123	31
C5	20	0.0074783	32
Run number	Pressure, mBar	Maximum deposition (ml/m^2)	Percentage of fuel reaching the ground
D-1	970	0.014588	23
D-2	980	0.014639	24
D-3	990	0.014694	24
D-4	1000	0.014747	24
Run number	Altitude, meters	Maximum deposition (ml/m^2)	Percentage of fuel reaching the ground
E-1	2000	0.053397	30
E-2	3000	0.032968	27
E-3	4000	0.023776	25
E-4	5000	0.018521	14
E-5	6000	0.014939	24
Run number	Aircraft type	Maximum deposition (ml/m^2)	
F-1	KC-135	0.00351	
F-2	E-3A	0.00159	
F-3	B-1B	0.00539	
Run number	Fuel type	Maximum deposition (ml/m^2)	Percentage of fuel reaching the ground
G-1	JP-8	0.014747	24
G-2	JP-4	0.0040432	5
G-3	JP-8/JP-4 (50/50 mix)	0.0074612	10
Run number	Wind direction	Maximum deposition (ml/m^2)	%of fuel reaching the ground
H-1	0	0.014929	24
H-2	45	0.012391	24
H-3	90	0.015138	24
H-4	135	0.10254	24
H-5	180	0.014747	24
H-6	225	0.012216	24
H-7	270	0.015363	24
H-8	315	0.10691	24

TABLE 16:

THE FJSIM SENSITIVITY ANALYSIS FOR THE E-3A

Run number	Air speed, mph	Maximum deposition (ml/m^2)	Percentage of fuel reaching the ground
A-1	200	0.0081565	22
A-2	250	0.0030107	10
A-3	300	0.0012812	6
A-4	350	5.04E-04	1.5
A-5	400	4.411E-04	1
Run number	**Wind speed (G.L), mph**	**Maximum deposition (ml/m^2)**	**Percentage of fuel reaching the ground**
B-1	2.3	0.046267	24
B-2	10	0.011277	22
B-3	20	0.0057405	22
B-4	30	0.0038776	22
B-5	40	0.002932	21
Run number	**Temp (G.L) °C**	**Maximum deposition (ml/m^2)**	**Percentage of fuel reaching the ground**
C-1	-20	0.0098127	10
C-2	-10	0.0091668	15
C-3	0	0.0081565	22
C-4	10	0.006158	29
C-5	20	0.00405	30
Run number	**Pressure, mBar**	**Maximum deposition (ml/m^2)**	**Percentage of fuel reaching the ground**
D-1	970	0.0081395	22
D-2	980	0.0081695	22
D-3	990	0.0082005	23
D-4	1000	0.0082319	23
Run number	**Altitude, meters**	**Maximum deposition (ml/m^2)**	**Percentage of fuel reaching the ground**
E-1	2000	0.030124	30
E-2	3000	0.018482	25
E-3	4000	0.013225	24
E-4	5000	0.010289	23
E-5	6000	0.0083638	23

Run number	Aircraft type	Maximum deposition (ml/m^2)	Percentage of fuel reaching the ground
F-1	KC-135	0.00351	
F-2	E-3A	0.00159	
F-3	B-1B	0.00539	
Run number	Fuel type	Maximum deposition (ml/m^2)	Percentage of fuel reaching the ground
G-1	JP-8	0.00823	23
G-2	JP-4	0.0022128	5
G-3	JP-8/JP-4 (50/50 mix)	0.0040591	10
Run number	Wind direction	Maximum deposition (ml/m^2)	Percentage of fuel reaching the ground
H-1	0	0.00829	22
H-2	45	0.0069768	22
H-3	90	0.0083625	22
H-4	135	0.05613	22
H-5	180	0.00823319	23
H-6	225	0.0070472	23
H-7	270	0.0084608	23
H-8	315	0.058109	23

From the sensitivity analysis, we found that airspeed has a major impact on the maximum deposition of jettisoned fuel that reaches the ground as shown in Figure 69.

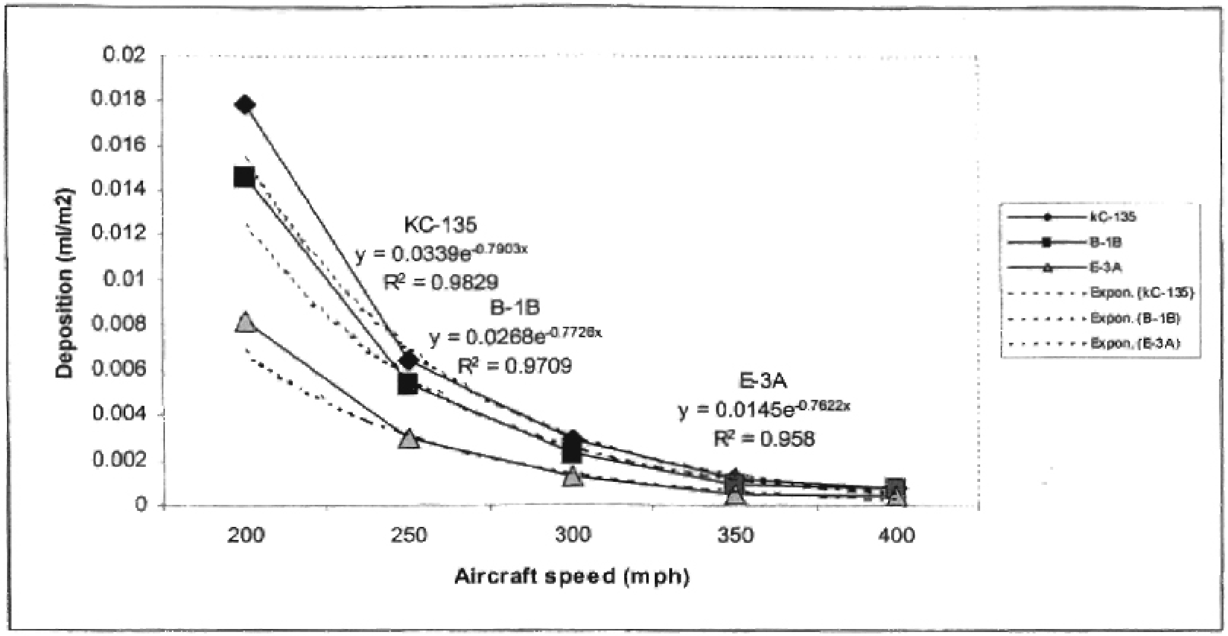


Figure 69: Impact of Aircraft speed with maximum deposition

Figure 69 shows the exponential equations for all three aircraft. The equations (empirical through best-fit curve) of maximum deposition versus aircraft speed are exponential functions, with maximum deposition increasing dramatically as aircraft speed is reduced below 250 mph for all three aircraft, as can be seen in Figure 69. While the model allows airspeed as low as 10 mph, the minimum aircraft speed used in this analysis was 200 mph. However, the results of the analysis recommend not reducing aircraft speed below 250 mph.

Figure 70 shows the impact on maximum deposition when pressure is changed.

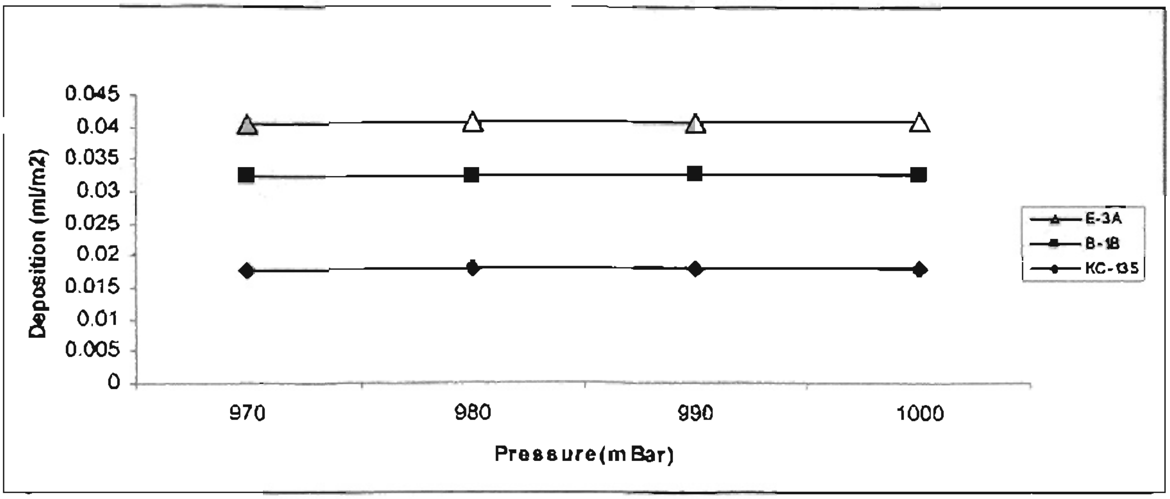


Figure 70: Impact of Pressure with maximum deposition

Figure 70 shows that changes in pressure have negligible effect on maximum deposition of jettisoned fuel that reaches the ground. Although pressure is an important variable in the evaporation of the fuel droplets, the range of ground level atmospheric pressure seen historically in the study area was rather narrow. Therefore, the model is not very sensitive to pressure.

Change in altitude also plays a critical role in change in deposition. Figure 71 shows that the higher the jettisoning altitude, the more disperse the fuel becomes as it falls. At high altitude, more evaporation takes place; hence, the ground level deposition becomes lower. The plot shows that maximum ground level increased dramatically when the altitude was lowered from 3,000 meters. Tinker AFB regulations specify that jettisoning event should perform at or above 20,000 feet AGL, whenever possible and should not be below 5,000 feet AGL.

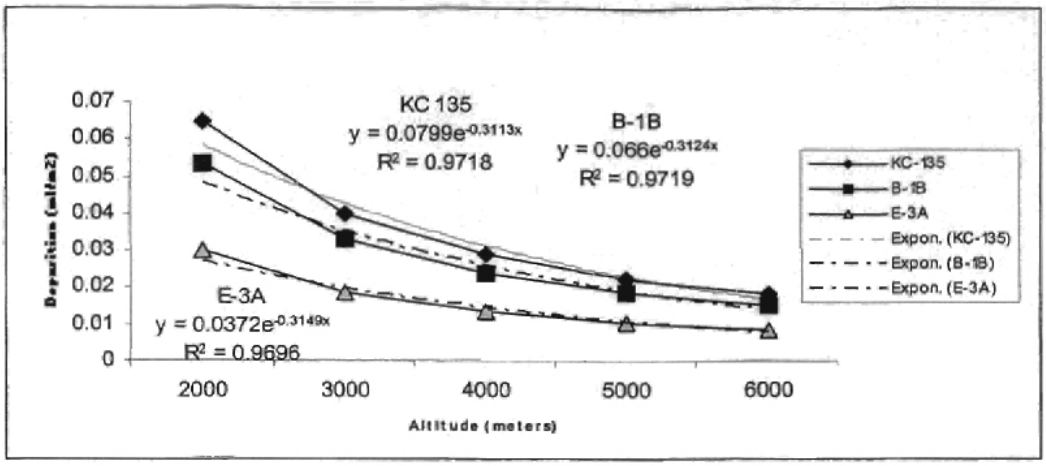


Figure 71: Impact of altitude with Maximum deposition

Figure 72 shows that impact on maximum deposition when the fuel type is varied.

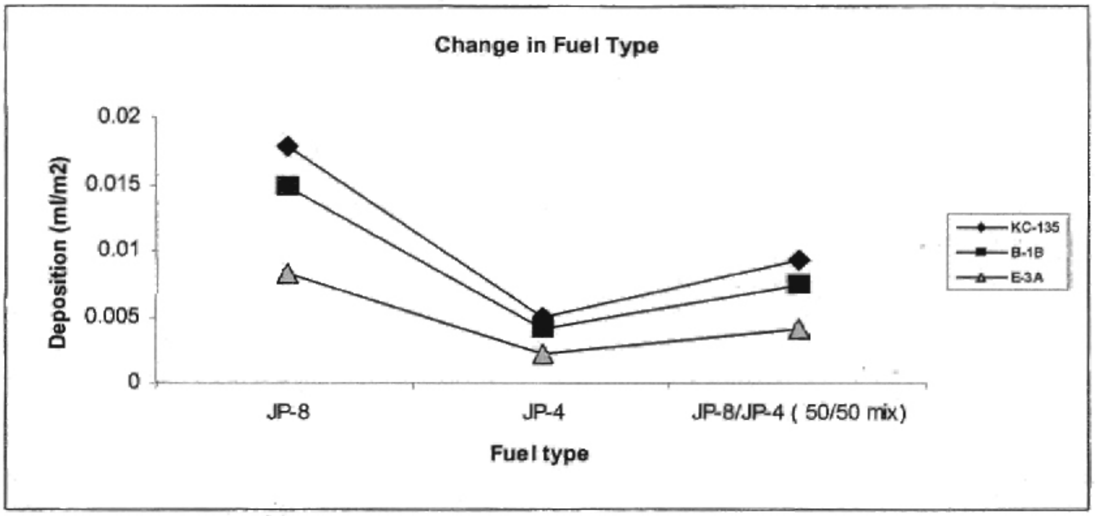


Figure 72: Impact of Fuel Type with Maximum deposition

This is of primarily historical interest, since JP-4 has been completely phased out. JP-8 results in a higher ground level deposition than that of JP-4. Despite this JP-8 is preferred because JP-4 has a very low freeze point (-58°C), which is ideal for cold climate flying. The USAF began converting from JP-4 to JP-8 for safety reasons because its lesser volatility reduces the risks of in-flight/post-crash fires and ground handling accidents. A mixture of these two fuel types has a lower ground level maximum deposition than pure JP-8, but higher deposition that pure JP-4. It is seen from the plot below that, although 50-50% mixture of JP-4 and JP-8 were taken, the maximum deposition of this mixture is not the average of JP-8 and JP-4 maxima.

The impact on deposition when wind speed is varied is given in Figure 73.

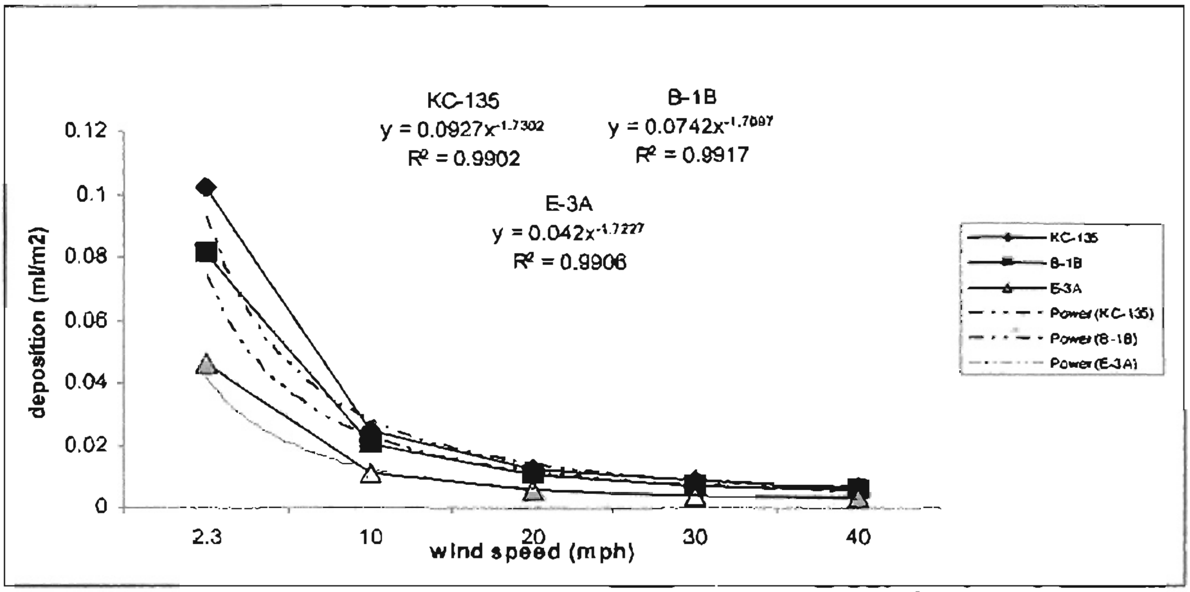


Figure 73: Impact of wind speed on Maximum deposition

Surface-level wind speed was varied between the lowest value accepted by the model, 2.3 mph, and 40 mph, as indicated in Figure 73. Sustained wind speeds above 40 mph are rare, even in Oklahoma, and would not persist for the long periods needed to model complete groundfall of the fuel plume. Winds act to disperse the jettisoned fuel droplets, so that higher winds will reduce the maximum ground level deposition. This is particularly true at lower temperatures when the fuel droplets are airborne for a longer period. Wind speed has an impact on maximum ground level deposition, but the impact is minor at wind speeds above about 10 mph. Wind speed will have more of an impact on the location of groundfall.

Figure 74 shows the result of maximum deposition when wind direction is changed for all three aircraft. Wind direction has an interesting and unanticipated impact on the maximum ground level deposition as can be seen in the Figure 74. A wind direction aligned with the aircraft direction, or any multiple of 90 degrees from that direction, results in a lower ground level deposition than a wind directions displaced 45 degrees from the aforementioned angles.

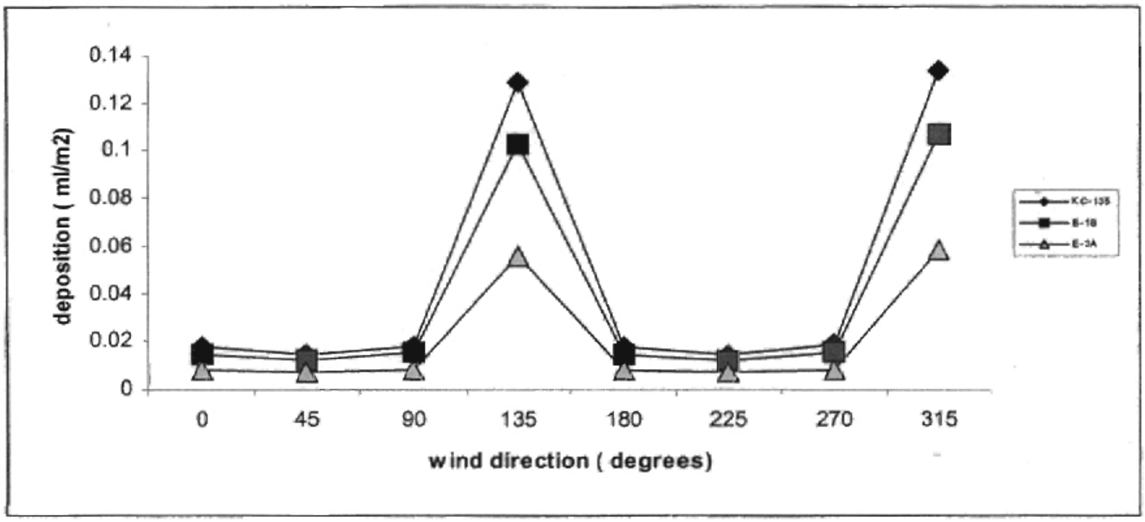


Figure 74: Impact of wind direction with Maximum deposition

Figure 75 shows the impact of temperature in maximum ground level deposition. Ground-level temperature has less impact on maximum ground level deposition than expected. At lower temperatures, less fuel evaporates/volatilizes, but the rate of fall is also reduced, so that plumes are more spread out as upper-atmosphere winds disperse the suspended fuel droplets. The relationship between ground level temperature and maximum fuel deposition is shown in Figure 75. An increase in temperature from –20 degrees C to + 20 degrees C reduces the maximum ground level deposition by approximately 50%.

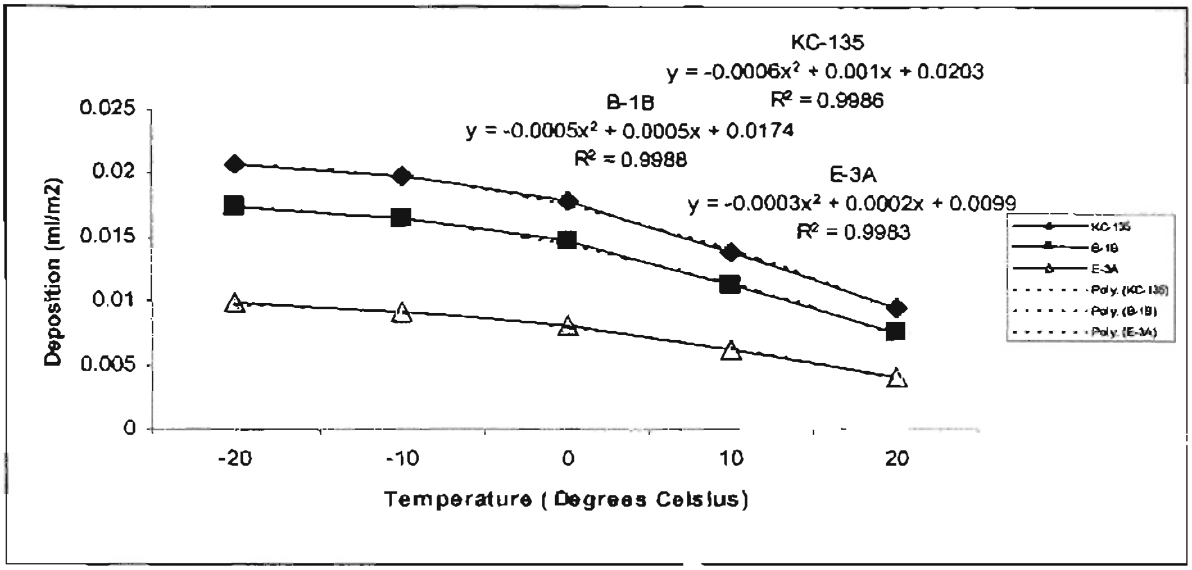


Figure 75: Impact of temperature with Maximum deposition

Environmental Impacts

This section examines the environmental impacts of the reasonable worst-case scenario of a low-level jettison event. From the tables summarizing the results of the runs in Table 1, Table 2 and Table 3 in Appendix G, the maximum ground level deposition was found in February 4, 1996. In this case, the fuel was jettisoned from 5,000 feet AGL and the amount of JP-8 fuel for the B-1B was 12,000 lbs. The maximum ground level deposition as can be seen in Figure 46, Chapter 6, was 16.17 mg/m^2. We compared this maximum ground level deposition with the regulatory standards for several environmental factors, in order to know the environmental impact of fuel jettisoning. Results are discussed below.

6.3.1 Soil Contamination

Over the past decades, many research and field studies have characterized the interaction of hydrocarbons in soil and evaluated the performance of bioremediation processes for these hydrocarbons. Table 3, Chapter 2, shows the Oklahoma Cleanup

Standards for hydrocarbon contaminated soil. We assumed that the top 6 inches (15 cm) of soil was contaminated after this fuel jettisoning event on February 4, 1996. Taking the reasonable worst-case scenario for a B-1B Lancer on February 4, 1996, i.e., the deposition is 16.17 mg/m^2. Figure 76 shows the three dimensional soil sample.

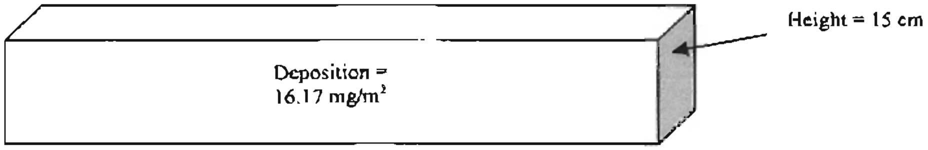


Figure 76: Three dimensional soil sample

Therefore, Deposition = 16.17 mg/m^2/ 0.15 m = 107.8 mg/ m^3 of JP-8 fuel

We considered a representative value for specific weight of soil, i.e., 2.5 gm/cm^3. Therefore, the maximum deposition from a jettison event would be

(107.8 mg/ m^3 of JP-8 fuel)/ 2.5 gm/cm^3

=0.04312 mg/kg.

This value is below action levels as well as below detection levels for every constituents present in Table 3, Chapter II.

6.3.2 Groundwater contamination

Oklahoma cleanup standards for hydrocarbon contaminated groundwater listed in Table 4, Chapter 2, show that the detection levels for all constituents of hydrocarbons are below 1 mg/L. We assumed that the worst-case scenario of the maximum ground level from the reasonable worst-case jettison event dissolved in a sheet of water 1.0 inches (2.5 cm) deep. A square meters received 16.17 mg of hydrocarbons. When these contaminants penetrate 2.5 cm deep, the maximum mg/ m^3 of JP-8 fuel that could occur would be: (16.17 mg/m^2)/ (2.5 cm) = 0.6465 mg/L, which is less than the action level of all the constituents given in Table 4, Chapter 2, except benzene. The action level for benzene is 0.005mg/L. However, once the groundfall hydrocarbons become mixed into deeper water, the mg/ m^3 of JP-8 fuel drops further. We assumed that the impacted depth of groundwater was 1 m, and the maximum mg/ m^3 of JP-8 fuel was 1.617 $\mu g/m^3$. This mg/ m^3 of JP-8 fuel were far below the action level for all the constituents presented in Table 4, Chapter 2.

6.3.3 Laboratory detection

Oklahoma cleanup standards for hydrocarbon contaminated soil and groundwater listed in Table 3 and Table 4, Chapter II, respectively show that the detection levels for all the constituents of hydrocarbons are 1 mg/kg in case of contaminants in soil and 1 mg/L in the case when the contaminants are in groundwater. The detection levels are above the maximum value that could occur from the worst-case jettison event.

6.3.4 Animal toxicity

The LD_{50} (dose that kills 50% of a test population) for the rabbit for jet fuel is 5 g/kg (MSDS, 1999). The average rabbit weighs 2-5kg (Harkness, 1995). Using a 2 kg weight, the lethal dose for 50% of the population would be 10 g of hydrocarbons. The maximum mg/ m^3 of JP-8 fuel in the worst-case scenario was 16.17 mg/m^2. In order to be affected by this mg/ m^3 of JP-8 fuel of fuel, a 2-kg rabbit would have to consume all the fuel falling on 618 square meters, which is not reasonable. Toxicity to other animals could not be assessed due to lack of data.

6.3.5 Human toxicity

The Occupational Safety and Health Administration (OSHA) and the Air Force office of Safety and Health (AFOSH) have set an exposure limit of 400 mg of petroleum products per cubic meter of air for an 8-hour workday, 40 –hour workweek, as mentioned in Chapter 2. The highest level in ambient air that would occur from the reasonable worst-case jettison event was less than 16.17 mg/m^2. The exact concentration cannot be calculated from this model, but the maximum concentration would be below 16.17 mg/m^3, since the total time required for 85% of fuel to make groundfall from this worst-case simulated event was approximately 30 minutes (as can be seen in Vapor Aloft plot in Figure 16(c), Appendix H). The maximum concentration is not only far below the AFOSH standard, it would persist for a few minutes. Therefore, a jettisoning event should not harm anyone at ground level.

6.3.6 Impact on threatened/endangered species

There are no toxicity data sets for JP-8 on any threatened or endangered species. However, the ground level mg/ m^3 of JP-8 fuel was below detection limits. Therefore, it is highly unlikely that a jettison event, even under extreme conditions, would affect threatened and endangered species.

Chapter 7

Conclusions and Recommendations

7.1 Conclusions

Based on this investigation, the results demonstrated that a jettisoning event that is carried out according to OC-ALC-TAFB Regulation 60-1 is unlikely to cause significant environmental impact. Even in the extreme conditions of cold weather, stable atmosphere and low winds, jettisoning events carried out at 5,000 feet AGL did not result in predicted ground concentration above laboratory detection limits.

Other findings are as follows;

1. The model is sensitive to several factors, including temperatures and wind speed/direction with altitude at the time of jettisoning event. It is very important for us to provide accurate values for these parameters to get a precise location of the simulated plume after jettisoning.
2. In order to get the accurate results, the model needs to be run only with a full meteorological data set.
3. Compared with the impact of JP-4 jet fuel, the jettisoning of JP-8 jet fuel does result in substantially more jet fuel reaching the surface as could be seen in Figure 72, Chapter 6.
4. The surface and atmospheric temperature influence the evaporation rate of the jet fuel. Maximum ground-level concentration increased with decreased

temperature. However, small differences in temperature did not make a major difference in maximum ground level concentration.

5. Maximum ground level concentration decreased with increasing altitudes. Below 10,000 feet AGL, ground level concentration increases rapidly with decreasing altitude.

6. Maximum ground level concentration also increased with decreasing aircraft speed. Minor variation in aircraft speed around cruise speed did not have significant impact. However, reducing airspeed below 250 mph results in rapidly increasing ground level concentration.

7. Maximum ground level concentration decreased with increasing wind speed. An increase in wind speed from 2.3 mph to 20 mph reduced maximum ground level concentration by an order of magnitude. Location of ground fall also shifted away from the jettison path as wind speed increased.

8. Change in wind direction changed the location of ground fall of the plume. It also had impact on maximum concentration of the contaminants. Figure 63 and Figure 65, Chapter 6, show how the location of the plume changes with wind direction.

9. The B-1B and the KC-135 have almost double the jettison rate of the E-3A. Therefore, the groundlevel concentration from a jettison event using a B-1B or a KC-135 would be almost that of an E-3A.

10. Integration of FJSIM model with GIS was possible with the help of output from deposition grid.

As a whole, it can be concluded that the significance of the impact of JP-8 jet fuel jettisoning is dependent upon several factors like altitudes, surface temperature, and weather conditions. If fuels are released above 20,000 feet AGL at a non-freezing surface temperature, the impact of JP-8 is negligible. For lower release altitude and temperature, the impact might be significant although our study showed that there is no significant environmental impact even at the worst-case scenario. Repeated jettisoning events at low altitude might have environmental impact.

Therefore, the combination of FJSIM and GIS can be used to estimate the impact and prepare an adequate response.

7.2 Recommendations

Based on the findings of this study, several suggestions are presented for future studies, which are as follows;

1. Lack of data of fuel jettisoning events was the main problem we faced in this project. As these data are provided, this mathematical model can be improved and expanded to include this information.
2. The isopleth from the FJSIM model can be overlain on important GIS coverage like watersheds, streams, school areas, hospitals, forest, vegetation, etc., in order to know the effect of the plume on these receptors.
3. The model does not take precipitation into account. A release of fuel into a rainfall event could behave significantly differently from the same release in a dry atmosphere. This should be studied.

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APPENDIX A

DERIVATION OF LAGRANGIAN MODEL, GAUSSIAN MODEL AND EVAPORATION MODEL

Lagrangian Model

A Lagrangian approach is used to develop the equations of motion of discrete particles released from aircraft, with the resulting set of ordinary differential equations solved exactly from time step to step. Particle flight path as a function of time after release is computed as the locations (X, Y, Z) for all particles included in the simulation; velocity is denoted by (U, V, W). The X direction is taken as downstream of the aircraft flight path; the Y direction is off the right wing as viewed from the pilot; and the Z direction is vertical upward. The interaction of the material with the turbulence in the environment creates turbulent correlation functions for the position and velocity, $<yv>$ and $<zw>$; for the velocity variance $<vv>$ and $<ww>$; and for the position variance, $<yy>$ and $<zz>$. The square root of these last two variables gives the horizontal and vertical standard deviations of the material motion about the mean described by Y and Z.

The governing equations are derived as

$$d^2X_i/dt^2 = (U_i - V_i)[1/\tau_p] + g_i \quad (.1)$$

$$dX_i/dt = V_i \quad (.2)$$

$$d/dt<x_i x_i> = 2<x_i v_i> \quad (.3)$$

$$d/dt<x_i v_i> = (<x_i u_i> - <x_i v_i>)[1/\tau_p] + <x_i v_i> \quad (.4)$$

$$d/dt<v_i v_i> = 2(<u_i v_i> - <v_i v_i>)<x_i v_i>)[1/\tau_p] \quad (A.5)$$

When X_i, V_i, and U_i are the ensemble averaged *i*th components of material position, material velocity and local fluid velocity, respectively, while x_i, v_i, and u_i are the fluctuating *i*th components of material position, material velocity and local fluid velocity, respectively; and g_i is (0,0,-g). Inherent in the equations is a relaxation time τ_p, the e-folding time for the released particle to come up to speed with the local fluid velocity (for V_i to approach and equal U_i) defined by

$$\tau_p = 4/3\ D\rho_t / C_D\ V_{rel}\ \rho_a \quad (.5)$$

Where D is the droplet diameter, ρ_t is material density, C_D is the particle drag cor=efficient, v_{rel} is the relative velocity $|U_i - V_i|$ between the material velocity and the local background velocity, and ρ_a is air density.

Equation 1 to 5 cannot be solved without specifying relationships for the quantities $<x_i u_i>$ and $<u_i v_i>$, the correlations of the particle position and particle velocity fluctuation. These expressions are developed by integrating their ensemble averaged frequency spectra using a spectral density function for transverse velocity fluctuations in isotropic turbulence.

$$<u_i v_i> = q^2/3\ [\ -\tau_{pK+}/\tau_t/2] \quad (.6)$$

$$<u_i v_i> = q^2/3\ K \quad (.7)$$

With

q^2= mean squares turbulence level = $<uu>+<vv>+<ww>$

$$K=1/2\ \{[3-(\tau_p/\tau_t)^2][1-\tau_p/\tau_t] + (\tau_p/\tau_t)^2 - 1\}/[1-(\tau_p/\tau_t)^2]^2 \quad (A.9)$$

And τ_t is the travel time of the particle through a turbulent eddy of scale Λ, adjusted for the passive tracer limit $\tau_t = \Lambda/(V_{rel} + 3/8q)$

Gaussian model

The dispersion model calculates deposition downwind form a nearly instantaneous elevated line source oriented at an arbitrary angle with respect to the mean wind direction. The axis of the spray cloud is assumed to be inclined from the horizontal plane by an angle proportional to V_i/u, where V_i is the gravitational settling velocity for the *i*th drop size category and u is the mean transport wind speed. The model uses a Cartesian coordinate system for a line source of length L at a release height H and calculation point at R (ε, δ, $\dot{z}$).

The amount of spray material released from an instantaneous volume source that is deposited on the ground through gravitational settling is obtained from the expression

$$DEP_v = -\frac{Q_v}{\sigma_y\sqrt{2\pi}}\exp\left[-\frac{1}{2}\left(\frac{y}{\sigma_y}\right)^2\right]\sum_{i=1}^{m} f_i\frac{d}{dx}\left[\frac{1}{\sigma_z\sqrt{2\pi}}\times\int_{-\infty}^{\infty}A(x,z)\,dz\right] \tag{B.1}$$

where,

$$\begin{aligned}
A(x,z) = {} & \sum_{j=0}^{\infty}\gamma_i^{j}\exp\left[-\frac{1}{2}(2jH_m - H + z + V_i x/u)^2\right] \\
& +\sum_{j=0}^{\infty}\gamma_i^{j+1}\exp\left[\frac{1}{2}\left(\frac{2jH_m - H + z - V_i x/u}{\sigma_z}\right)^2\right] \\
& +\sum_{j=1}^{\infty}\gamma_i^{j}\exp\left[-\frac{1}{2}\left(\frac{2jH_m + H + z - V_i x/u}{\sigma_z}\right)^2\right] \\
& +\sum_{j=1}^{\infty}\gamma_i^{j-1}\exp\left[-\frac{1}{2}\left(\frac{2jH_m - H \cdot z + V_i x/u}{\sigma_z}\right)^2\right]
\end{aligned} \tag{B.2}$$

Where Q_v is the strength of the volume source; σ_y the standard deviation of the crosswind spray distribution; σ_z the standard deviation of the vertical spray distribution; (x,y,z) are the alongwind, crosswind and vertical coordinates of the point at which the deposition is calculated; f_i the mass fraction of the total source strength in the ith dropsize category (total number of dropsizes is NI): γ_i the reflection coefficient for the median drop by mass in the ith dropsize category; and H_m the depth of the surface mixing layer beneath a capping inversion. The laterial and vertical growth of the apray cloud due to turbulent mixing is assumed to be rectilinear, $\sigma_y = \sigma_a(x + x_v)$ and $\sigma_z = \sigma_E(x+x_v) = \sigma_a(x + x_v)/k$, where σ_a is the standard deviation of the wind azimuth angle, σ_E is the standard deviation of the wind elevation angle; k= σ_a/σ_E; x_v is the virtual distance = $k\sigma_o/\sigma_A - x_R = \sigma_o/\sigma_E - x_R$; and σ_o is the standard deviation of the cloud distribution at the distance x_R downwind from the volume source.

After substitution for σ_y and σ_z, and performing the indicated integration and differentiation, the deposition equation takes the form

$$DEPv = \frac{kQv}{2\pi\sigma_A^2(x+x_v)^3}\exp\left[-\frac{1}{2}\left(\frac{y}{\sigma_A(x+x_v)}\right)^2\right]\times\sum_{i=1}^{NI} f_i(1-\gamma_i)[NM+NM] \tag{B.3}$$

where,

$$MM = \left[H + Vx_v / u\right]\exp\left[-\frac{k^2}{2}\left(\frac{H - Vx/u}{\sigma_z(x + x_v)}\right)^2\right] \tag{B.4}$$

$$NN = \sum_{j=1}^{n} \gamma_i^{j-1}\left[2jH_m - H - V_i x_v / u\right]$$

$$\times \exp\left[-\frac{k^2}{2}\left(\frac{2jH_m - H - Vx/u}{\sigma_z(x + x_v)}\right)^2\right]$$

$$+\sum_{j=1}^{n} \begin{matrix} \gamma_i^j\left[2jH_m + H + Vx/u\right] \\ \times \exp\left[-\frac{k^2}{2}\left(\frac{2jH_m + H - Vx/u}{\sigma_z(x + x_v)}\right)^2\right] \end{matrix} \tag{B.5}$$

The expression for deposition downwind from a line source oriented at an arbitrary angle θ with the wind direction is derived through consideration of the appropriate line source geometry. A finite line source of length L may be directed along the δ coordinate at height H with one end of the line source at the point ε =0, δ=0, and z = H. It may be shown that x = x'-δ'sinθ; y =δ'cosθ +x'tanθ-δ/cosθ; and x'=εcosθ+δsinθ. When these expressions are substituted for x,y and x' in equation (B.3), the deposition at any point R downwind from the line source becomes

$$
DEP_L = \frac{2S}{\sin\theta}\sum_{i=1}^{NI} f_i\left(1-\lambda_i\right)\left\{
\begin{aligned}
&\frac{B\exp\left(\frac{G^2}{4F}-P\right)}{2F}
\times\left[
\begin{aligned}
&\exp\left[-F\left(\frac{1}{a}-\frac{G}{2F}\right)^2\right]\\
&-\exp\left[-F\left(\frac{1}{b}-\frac{G}{2F}\right)^2\right]\\
&+\frac{G\sqrt{\pi}}{2\sqrt{F}}\left\{
\begin{aligned}
&erf\left[\left(\frac{1}{b}-\frac{G}{2F}\right)\sqrt{F}\right]\\
&-erf\left[\sqrt{F}\left(\frac{1}{a}-\frac{G}{2F}\right)\right]
\end{aligned}\right\}
\end{aligned}\right]+\\
&\sum_{j=1}^{\alpha}\gamma_i^{j-1}\frac{C\exp\left(\frac{J^2}{4I}-P\right)}{2I}
\left\{
\begin{aligned}
&\exp\left[-I\left(\frac{1}{a}-\frac{J}{2I}\right)^2\right]\\
&-\exp\left[-I\left(\frac{1}{b}-\frac{J}{2I}\right)^2\right]\\
&+\frac{J\sqrt{\pi}}{2\sqrt{I}}\times\left\{
\begin{aligned}
&erf\left[\sqrt{I}\left(\frac{1}{b}-\frac{J}{2I}\right)\right]\\
&-erf\left[\sqrt{I}\left(\frac{1}{a}-\frac{J}{2I}\right)\right]
\end{aligned}\right\}
\end{aligned}\right\}\\
&\lambda_i^{j}\frac{D\exp\left(\frac{K^2}{4E}-P\right)}{2E}\\
&+\sum_{j=1}^{\alpha}\left\{
\begin{aligned}
&\exp\left[-E\left(\frac{1}{a}-\frac{K}{2E}\right)^2\right]\\
&-\exp\left[-E\left(\frac{1}{b}-\frac{K}{2E}\right)^2\right]+\\
&\frac{K\sqrt{\pi}}{2\sqrt{\pi}}\left\{
\begin{aligned}
&erf\left[\left(\frac{1}{b}-\frac{K}{2E}\right)\sqrt{E}\right]\\
&-erf\left[\left(\frac{1}{a}-\frac{K}{2E}\right)\sqrt{E}\right]
\end{aligned}\right\}
\end{aligned}\right\}
\end{aligned}
\right\}
\tag{B.6}
$$

Where,

$$a=\sqrt{2}\sigma_A\left(x'+x_v\right)$$

$$b=\sqrt{2}\sigma_A\left(x'+x_v \quad l\sin\theta\right)$$

$$B=H=V_i x_v / u$$

$$C=2jH_m-H-V_i x_v / u$$

$$D=2jH_m+H-V_i x_v / u$$

$$E=k^2 D^2+N^2$$

$$F=k^2 B^2+N^2$$

$$G=\sqrt{2}/\sigma_a\left[V_i B k^2 / u+N\cot\theta\right]$$

$$I=k^2 C^2+N^2$$

$$J=-\sqrt{2}/\sigma_a\left[V_i C k^2 / u+N\cot\theta\right]$$

$$K=\sqrt{2}/\sigma_a\left[V_i D k^2 / u+N\cot\theta\right]$$

$$N=\left(x'+x_v\right)\cot\theta+x'\tan\theta-\delta/\cos\theta$$

$$P=\frac{1}{2}\sigma_a{}^2\left[\left(kV_i/u\right)^2+\left(\cot\theta\right)^2\right]$$

$$S=Q_v k/2\pi$$

L= effective line length

Evaporation Model

The following development defines the major relationships used in Law's analysis to derive the governing equations for the multicomponent evaporation model. The overall forms of the expressions that result are similar to those given in the classical studies of single-droplet evaporation of Spalding (1953). First, given knowledge of the mole fraction for a given species as well as its molecular weight, the mass fraction of the component can be computed. Here W_i is the ratio of the molecular weight of species i to that of an inert reference species that does not participate in the evaporation process (typically air)

$$y_{i,s}(t) = \frac{X_{i,s}(t)W_i}{\left[1-\sum X_{i,s}(t)\right]+\sum X_{i,s}(t)W_i} \tag{C.1}$$

where

$X_{i,s}(t)$ is the mole fraction of component i in the vapor phase.

$$\varepsilon_i(t) = y_{i,s}(t) - \frac{y_{i,s}(t)\left[1-y_{i,s}(t)\right]}{\sum y_{i,s}(t)} \tag{C.2}$$

Using the aggregate latent heat of vaporization can be defined as

$$L(t) = \sum \frac{\varepsilon_i L_i}{L_r} \tag{C.3}$$

where L_i is the latent heat of vaporization and L_r is a reference latent heat value. Defining the terms

$$H(t) = \frac{\left[1-\sum y_{i,s}(t)\right]\left[T_\alpha - T_s(t) - L(t)\sum y_{i,s}(t)\right]}{\sum y_{i,s}(t)} \tag{C.4}$$

$$B(t) = \frac{T_\alpha - T_s(t)}{L(t)+H(t)} \tag{C.5}$$

Where T_α is the ambient temperature and T_s is the droplet surface temperature. The aggregate normalized evaporation rate may be defined using

$$m(t) = \ln\left[1+B(t)\right] \tag{C.6}$$

While the evaporation of any individual component can be computed using

$$m_i(t) = \varepsilon_i(t)m(t) \tag{C.7}$$

With these equations in hand, the computational procedure used in the multicomponent evaporation model can be outlined as follows. Given initial values for the fractional radius R, as well as for the surface temperature T_s and the mole fraction of each species $X_{i,s}$, we can define first order differential equations for the rate of change of radius, temperature and component mass

$$\frac{dR}{dT} = -\frac{1}{3} \cdot \frac{m(t)}{R(t)\rho(t)}$$

$$\frac{dT_x}{dT} = \frac{H(t)m(t)}{R^2(t)\rho(t)} \qquad \text{(C.8)}$$

$$\frac{dM_i}{dT} = -\varepsilon_i(t)m_i(t)$$

Where ρ(t) is density and M_i is mass. The equations are advanced in time as the drop descends to the surface.

(Source: "*A model for Assessing fuel jettisoning effects*", Atmospheric Environment, 28(16):2751-2759.)

APPENDIX B

METEOROLOGICAL DATA FROM NORMAN STATION, OKLAHOMA

TABLE 1

ATMOSPHERIC SOUNDING ON JULY 9, 2001 FROM NORMAN STATION, OKLAHOMA

72357 OUN Norman Observations at 12Z 09 Jul 2001

PRES hPa	HGHT m	TEMP C	DWPT C	RELH %	MIXR g/kg	DRCT deg	SKNT knot	THTA K	THTE K	THTV K
1000.0	111									
973.0	357	23.4	18.6	74	14.06	200	6	298.9	340.0	301.4
972.9	358	23.4	18.6	74	14.06	200	6	298.9	340.1	301.4
945.5	609	25.9	18.0	62	13.95	215	34	303.8	345.6	306.4
935.0	707	26.8	17.8	58	13.91	218	32	305.8	347.7	308.3
925.0	802	26.6	16.6	54	13.01	220	30	306.5	345.9	308.9
913.3	914	26.0	15.9	54	12.58	225	27	307.0	345.2	309.4
882.1	1219	24.5	13.9	52	11.44	230	18	308.5	343.5	310.6
852.0	1523	22.9	11.9	50	10.40	240	12	309.9	342.0	311.9
850.0	1544	22.8	11.8	50	10.33	240	12	310.0	341.9	311.9
822.5	1828	20.3	10.9	55	10.05	250	9	310.3	341.4	312.1
793.9	2133	17.6	9.9	61	9.76	230	2	310.5	340.8	312.4
784.0	2241	16.6	9.6	63	9.66	179	2	310.6	340.5	312.4
768.0	2417	16.4	-1.6	29	4.45	95	1	312.2	326.6	313.1
766.1	2438	16.2	-1.7	29	4.43	85	1	312.3	326.5	313.1
739.0	2743	13.8	-3.3	30	4.08	55	3	312.8	326.1	313.6
737.0	2765	13.6	-3.4	31	4.06	55	3	312.9	326.0	313.6

TABLE 2

ATMOSPHERIC SOUNDING ON NOVEMBER 18, 2002 FROM NORMAN STATION, OKLAHOMA

72357 OUN Norman Observations at 12Z 18 Nov 2002

PRES hPa	HGHT m	TEMP C	DWPT C	RELH %	MIXR g/kg	DRCT deg	SKNT knot	THTA K	THTE K	THTV K
1000.0	72									
967.0	357	11.6	2.6	54	4.79	190	15	287.5	301.4	288.3
938.2	610	11.2	1.5	51	4.57	210	47	289.6	302.9	290.4
925.0	728	11.0	1.0	50	4.47	220	45	290.6	303.7	291.3
909.0	874	12.0	-1.0	41	3.93	232	43	293.0	304.8	293.7
904.7	914	13.5	-2.4	33	3.56	235	42	295.0	305.8	295.6
890.0	1053	18.8	-7.2	16	2.51	246	41	301.8	309.8	302.3
872.8	1219	17.8	-9.9	14	2.07	260	39	302.5	309.1	302.8
850.0	1445	16.4	-13.6	12	1.58	265	38	303.3	308.5	303.6
842.1	1524	16.0	-14.6	11	1.48	265	38	303.7	308.6	304.0
812.2	1829	14.6	-18.2	9	1.13	260	41	305.3	309.1	305.5
809.0	1863	14.4	-18.6	9	1.10	259	41	305.5	309.2	305.7
782.9	2134	12.2	-19.2	9	1.07	255	41	306.0	309.6	306.2
754.7	2438	9.7	-19.9	11	1.05	260	44	306.5	310.1	306.7
727.4	2743	7.2	-20.7	12	1.02	260	46	307.0	310.5	307.2
700.0	3061	4.6	-21.4	13	0.99	260	52	307.6	311.0	307.7
662.0	3513	1.0	-16.0	27	1.67	256	56	308.4	314.0	308.8
650.1	3658	0.3	-26.4	11	0.68	255	57	309.2	311.7	309.4

TABLE 3:
UPPER LAYER ATMOSPHERIC SOUNDINGS FOR FEBRUARY 3, 1996
72357 OUN Norman Observations at 12Z 03 Feb 1996

PRES hPa	HGHT m	TEMP C	DWPT C	RELH %	MIXR g/kg	DRCT deg	SKNT knot	THTA K	THTE K	THTV K
1000.0	276									
989.0	358	-17.1	-19.2	84	0.85	20	12	256.9	259.2	257.0
918.3	914	-15.8	-18.3	81	0.99	45	17	263.7	266.5	263.8
882.1	1219	-13.6	-14.7	91	1.39	50	12	269.0	273.0	269.2
871.0	1315	-14.1	-16.0	86	1.27	52	9	269.5	273.1	269.7
850.0	1500	-14.7	-16.8	84	1.21	55	4	270.7	274.3	270.9
813.7	1828	-16.4	-18.2	86	1.13	240	1	272.3	275.6	272.5
636.8	3657	-17.6	-21.1	74	1.12	295	32	290.7	294.3	290.9
454.6	6095	-33.5	-44.6	32	0.16	280	77	300.2	300.8	300.2

TABLE 4:
UPPER LAYER ATMOSPHERIC SOUNDINGS FOR MARCH 10, 1998
72357 OUN Norman Observations at 12Z 10 Mar 1998

PRES hPa	HGHT m	TEMP C	DWPT C	RELH %	MIXR g/kg	DRCT deg	SKNT knot	THTA K	THTE K	THTV K
1000.0	290									
992.0	357	-9.1	-13.0	73	1.42	0	10	264.7	268.6	264.9
922.1	914	-10.2	-31.4	16	0.30	5	21	269.1	270.1	269.2
819.6	1829	-6.9	-16.6	46	1.28	340	29	281.8	285.7	282.0
819.0	1834	-6.9	-15.9	49	1.36	340	29	281.9	286.0	282.1
728.4	2743	-10.1	-20.3	43	1.05	320	35	288.0	291.3	288.2
700.0	3049	-10.7	-23.7	34	0.81	325	41	290.6	293.2	290.8
645.6	3658	-14.9	-29.3	28	0.53	320	45	292.6	294.4	292.7
595.5	4267	-19.1	-35.0	23	0.33	310	49	294.6	295.7	294.6
571.8	4572	-21.2	-37.8	21	0.26	305	49	295.5	296.5	295.6
558.0	4756	-22.5	-39.5	20	0.22	305	50	296.1	296.9	296.1
548.9	4877	-22.9	-39.9	20	0.22	305	51	297.1	297.9	297.1
500.0	5560	-24.9	-41.9	19	0.19	295	66	302.6	303.3	302.7
484.2	5791	-26.6	-40.7	25	0.23	295	84	303.3	304.1	303.3
468.0	6036	-28.5	-39.5	34	0.27	291	74	303.9	304.9	304.0
464.0	6096	-28.9	-39.9	34	0.26	290	72	304.1	305.0	304.1
444.3	6401	-31.2	-42.2	33	0.21	285	68	305.0	305.8	305.1

TABLE 5:
UPPER LAYER ATMOSPHERIC SOUNDINGS ON DECEMBER 12, 2000
72357 OUN Norman Observations at 00Z 12 Dec 2000

PRES hPa	HGHT m	TEMP C	DWPT C	RELH %	MIXR g/kg	DRCT deg	SKNT knot	THTA K	THTE K	THTV K
1000.0	238									
985.0	357	-8.5	-13.3	68	1.40	0	14	265.8	269.7	266.0
953.0	610	-11.0	-14.6	75	1.30	350	19	265.8	269.4	266.0
925.0	839	-13.3	-15.8	81	1.21	350	19	265.7	269.1	265.9
915.9	914	-13.9	-16.1	84	1.20	355	19	265.8	269.2	266.0
879.7	1219	-16.5	-17.2	95	1.14	355	27	266.2	269.4	266.4
872.0	1285	-17.1	-17.4	98	1.13	354	31	266.3	269.5	266.4
850.0	1478	-13.3	-17.3	72	1.16	350	41	272.2	275.6	272.4
812.5	1829	-2.2	-23.6	18	0.70	330	45	287.5	289.8	287.6
644.7	3658	-4.1	-27.0	15	0.65	255	52	305.0	307.3	305.2
551.4	4877	-7.6	-35.9	8	0.33	270	62	314.8	316.0	314.8
469.6	6096	-17.1	-35.8	18	0.39	260	64	317.8	319.2	317.9

TABLE 6:
UPPER LAYER ATMOSPHERIC SOUNDINGS ON AUGUST 1, 2001
72357 OUN Norman Observations at 12Z 01 Aug 2001

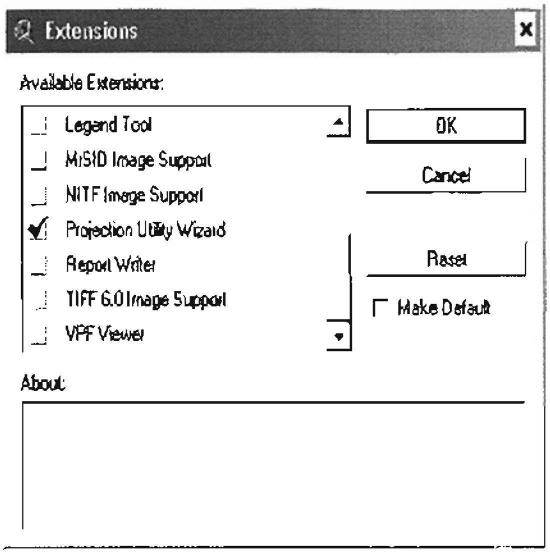
PRES hPa	HGHT m	TEMP C	DWPT C	RELH %	MIXR g/kg	DRCT deg	SKNT knot	THTA K	THTE K	THTV K
1000.0	145									
977.0	357	25.0	20.0	74	15.31	180	8	300.1	345.2	302.9
917.1	914	26.3	16.3	54	12.88	215	25	307.0	346.1	309.3
826.0	1829	20.5	10.5	53	9.72	220	6	310.[illegible]	340.1	311.9
665.6	3658	10.2	-6.2	31	3.64	165	12	318.3	330.4	319.0
573.5	4877	2.3	-18.2	20	1.60	125	10	322.9	328.6	323.2
500.0	5970	-4.5	-27.5	15	0.80	105	10	327.5	330.5	327.6
492.0	6096	-5.2	-28.0	15	0.78	100	10	328.1	331.0	328.2

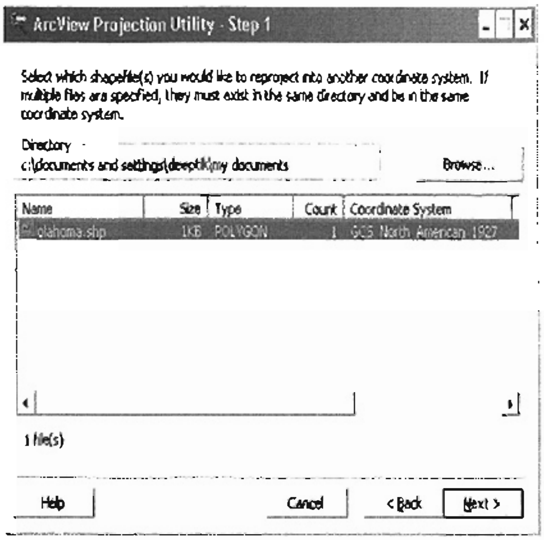
TABLE 7:
UPPER LAYER ATMOSPHERIC SOUNDINGS ON DECEMBER 15, 1998
72357 OUN Norman Observations at 12Z 15 Dec 1998

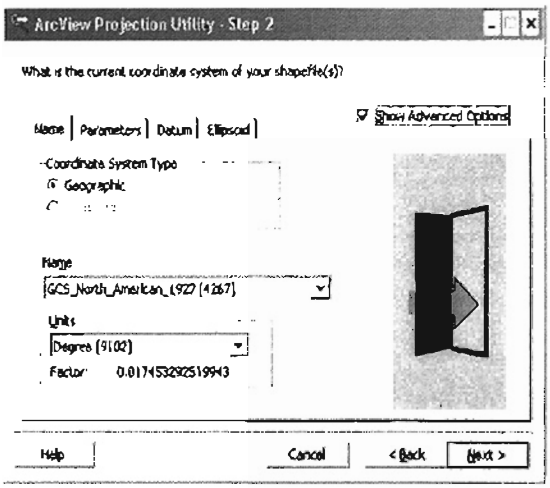
PRES hPa	HGHT m	TEMP C	DWPT C	RELH %	MIXR g/kg	DRCT deg	SKNT knot	THTA K	THTE K	THTV K
1000.0	237									
986.0	357	1.0	-1.1	86	3.59	190	4	275.3	285.2	275.9
921.2	914	8.5	-4.8	39	2.93	225	16	288.3	297.1	288.8
887.7	1219	7.5	-8.0	33	2.38	245	14	290.3	297.6	290.8
824.2	1829	6.7	-16.7	17	1.26	275	6	295.8	299.9	296.0
794.0	2134	4.6	-22.3	12	0.81	180	4	296.7	299.4	296.9
785.0	2227	4.0	-24.0	11	0.70	169	6	297.0	299.4	297.1
716.0	2974	3.8	-41.2	2	0.15	124	19	304.7	305.2	304.7
700.0	3157	2.4	-41.6	2	0.14	120	19	305.1	305.6	305.1
656.4	3658	-1.5	-43.4	2	0.13	105	17	306.4	306.9	306.4
607.1	4267	-6.2	-45.5	3	0.11	85	16	307.9	308.3	307.9
500.0	5780	-17.9	-50.9	4	0.07	50	17	311.1	311.4	311.2
479.1	6096	-20.2	-46.5	8	0.12	50	17	312.1	312.6	312.1

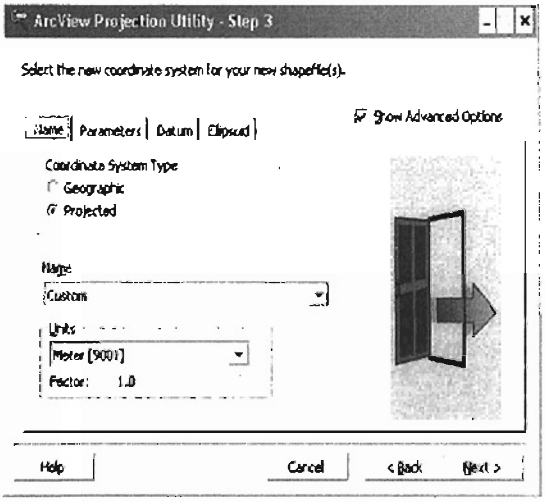
APPENDIX C

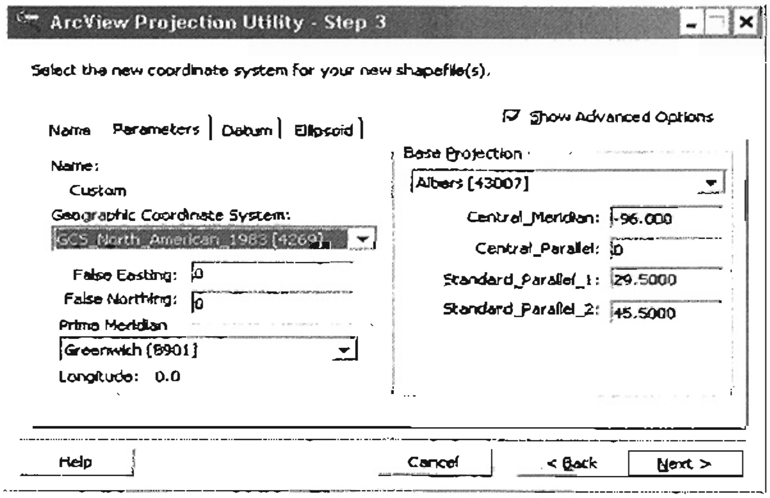
COORDINATES OF TINKER AIR FORCE BASE AND JETTISON ROUTE


Extensions
Available Extensions:
Legend Tool
MrSID Image Support
NITF Image Support
Projection Utility Wizard
Report Writer
TIFF 6.0 Image Support
VPF Viewer
OK
Cancel
Reset
Make Default
About:


ArcView Projection Utility - Step 1
Select which shapefile(s) you would like to reproject into another coordinate system. If multiple files are specified, they must exist in the same directory and be in the same coordinate system.
Directory
Browse...
Name
Size
Type
Count
Coordinate System
1 file(s)
Help
Cancel
< Back
Next >


ArcView Projection Utility - Step 2
What is the current coordinate system of your shapefile(s)?
Name
Parameters
Datum
Ellipsoid
Show Advanced Options
Coordinate System Type
Geographic
Name
GCS_North_American_1927 (4267)
Units
Degree (9102)
Factor: 0.0174532925199433
Help
Cancel
< Back
Next >


ArcView Projection Utility - Step 3
Select the new coordinate system for your new shapefile(s).
Name
Parameters
Datum
Ellipsoid
Show Advanced Options
Coordinate System Type
Geographic
Projected
Name
Custom
Units
Meter (9001)
Factor: 1.0
Help
Cancel
< Back
Next >


ArcView Projection Utility - Step 3
Select the new coordinate system for your new shapefile(s).
Show Advanced Options
Name
Parameters
Datum
Ellipsoid
Name:
Custom
Geographic Coordinate System:
GCS_North_American_1983 (4269)
False Easting: 0
False Northing: 0
Prime Meridian
Greenwich (8901)
Longitude: 0.0
Base Projection
Albers (43007)
Central_Meridian: -96.000
Central_Parallel: 0
Standard_Parallel_1: 29.5000
Standard_Parallel_2: 45.5000
Help
Cancel
< Back
Next >

APPENDIX D

EXPORT DATA FROM THE FJSIM MODEL TO MICROSOFT ACCESS 2000

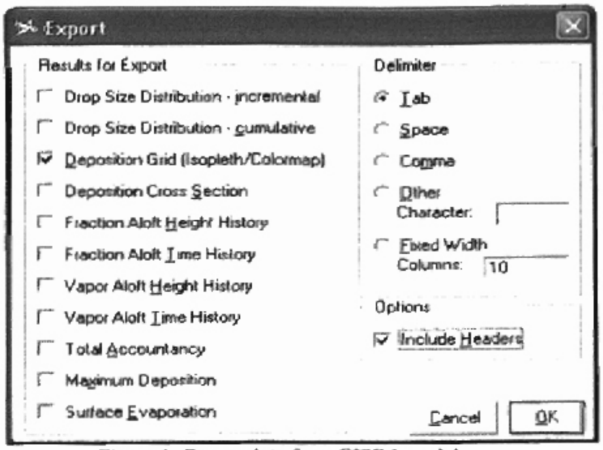


Figure 1. Export data from FJSIM model

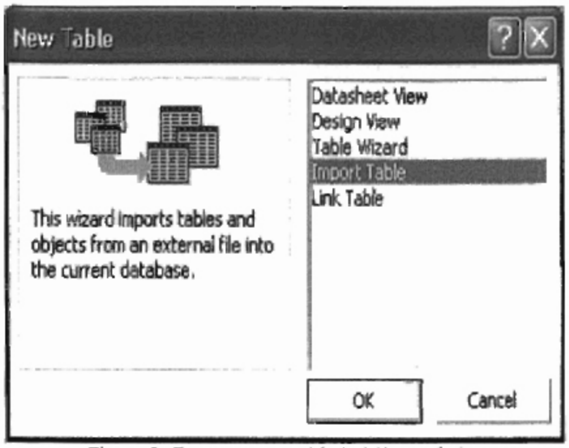


Figure 2: Export a new table in Microsoft Access

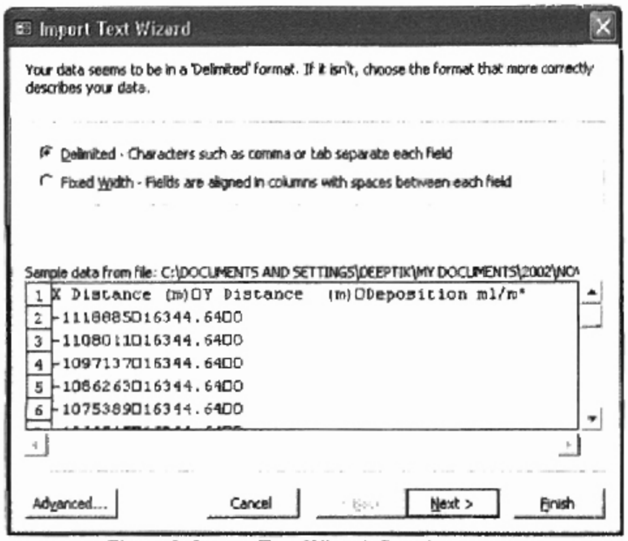


Figure 3: Import Text Wizard, Step 1

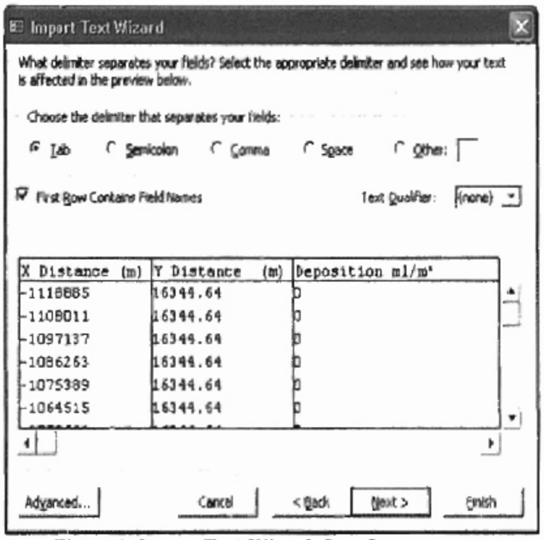


Figure 4: Import Text Wizard, Step 2

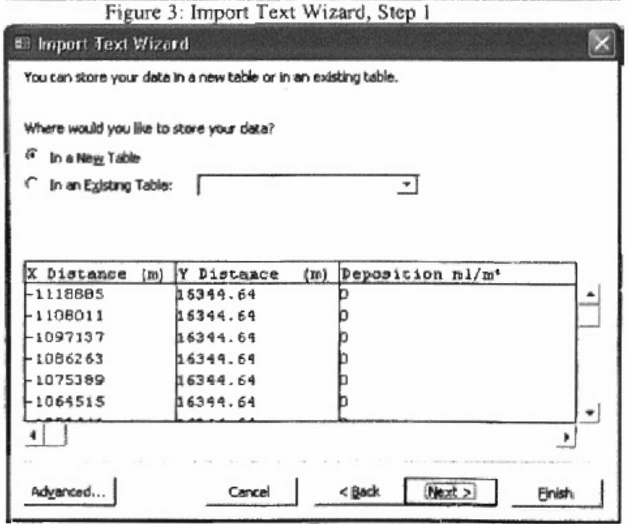


Figure 5: Import Text Wizard, Step 3

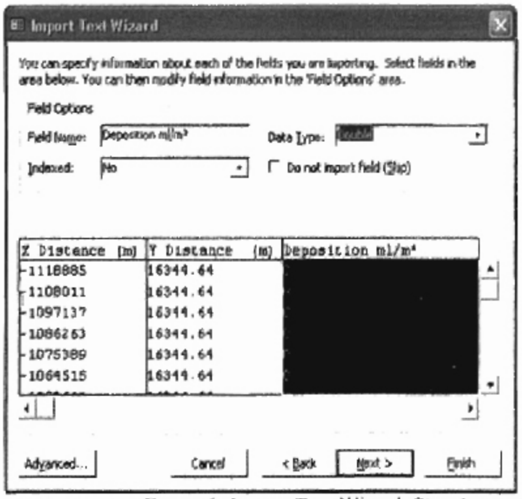


Figure 6: Import Text Wizard, Step 4

APPENDIX E

CHANGE OF COORDINATES BY ROTATION (SUBSTITUTION AND TRANSFORMATION)

Substitutions and transformations

Formulas for changes in coordinate systems can lead to confusions because moving the coordinate axes up has the same effect on equations as moving objects down while the axes stay fixed.

Substitutions

A **substitution**, or **change of coordinates**, relates the coordinates of a point in one coordinate system to those of *the same point in a different coordinate system*. Usually one coordinate system has the superscript' and the other does not, and we write,

$$X=F_X(X', Y'), \qquad (1)$$
$$Y=F_Y(X', Y')$$
or, $(X, Y)=F(X', Y')$

This means: given the equation of an object in the unprimed coordinate system, one obtains the equation of the same object in the primed coordinate system by substituting $F_X(X', Y')$ for X and $F_Y(X', Y')$ for Y in the equation. For instance, suppose the primed coordinate system is obtained from the unprimed system by moving the axes
up a distance d. then $X=X'$ and $Y=Y'+d$. The circle with equation X^2+Y^2+1 in the unprimed system has equation $X'^2+(Y'+d)^2=1$ in the primed system. Thus transforming an implicit equation in (X, Y) into in (X', Y') is immediate.

The point $P=(a, b)$ in the unprimed system, with equation $X=a$, $Y=b$, has equation $F_X(X', Y')=a$, $F_Y(X', Y')=b$ in the new system. To get the primed coordinates explicitly one must solve X' and Y' (in the example just given, we have $X'=a$, $Y'+d=b$, which yields $X'=a$, $Y'=b-d$). Therefore, if possible, we give the inverse equations.

$$X'=G_{X'}(X, Y),$$
$$Y'=G_{Y'}(X, Y)$$
or, $(X', Y')=G(X, Y)$

Which are equivalent to (1) if $G(F(X,Y))=(X,Y)$ and $F(G(X,Y))=(X,Y)$. Then to go from the unprimed to the unprimed system one merely plugs the known values of X and Y into these equations. This is also the best strategy when dealing with a curve expressed parametrically, that is: $X=X(t)$, $Y=Y(t)$.

Transformations

A transformation associates to each point (X, Y) a different point in the same coordinate system; we denote this by

$$(X, Y)\rightarrow F(X, Y) \qquad (2)$$

Where F is a map from the plane to itself (a two-component function of two variables). For example, translating down by a distance d is accomplished by $(X, Y)\rightarrow (X, Y-d)$. Thus the action of the transformation on a point whose coordinates are known (or on a curve expressed parametrically) can be immediately computed.

If, on the other hand, we have an object (say a curve) defined implicitly by the equation $C(X, Y)=0$, finding the equation of the transformed object requires using the inverse transformation $(X, Y)\rightarrow G(X, Y)$

Defined by $G(F(X, Y))=(X, Y)$ and $F(G(X, Y))=(X, Y)$. The equation of the transformed object is $C(G(X, Y))=0$. For instance, if C is the circle with equation $X^2+Y^2=1$ and we are translating down by a distance d, the inverse transformation is

$$(X, Y)\rightarrow(X, Y+d)$$

Translating up and the equation of the translated circle is $X2+(Y+d)^2=1$. Compare the example following (1).

Using transformations to perform changes of coordinates

Usually, we will not give formulas of the form (1) for changes between two changes between two coordinate systems of the same type, because they can be immediately derived from the corresponding formulas (2) for transformations.

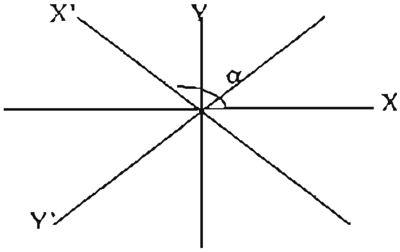


Figure 1: Change of coordinates by a rotation

Let the two Cartesian coordinate systems (X, Y) and (X', Y') be related as in Figure 1: they have the same origin and the positive X'-axis is obtained from the positive X-axis by a counterclockwise rotation through an angle α. If a point has coordinates (X, Y) in the unprimed system, its coordinates (X', Y') in the primed system are the same as the coordinates in the unprimed system of a point that undergoes the inverse rotation, that is, a rotation by an angle -α. This transformation acts as follows,
(X, Y)→..

Therefore the right hand side of 3 is (X',Y'), and the desired substitution is

$X'\ \ X \cos\alpha + Y \sin\alpha$
$Y' = -X \sin\alpha + Y \cos\alpha$

Switching the roles of the primed and unprimed systems, we get the equivalent substitution

$X'\ \ X \cos\alpha + -Y \sin\alpha$
$Y' = X \sin\alpha + Y \cos\alpha$

(Since the X-axis is obtained from the X'-axis by a rotation through an angle -α)

Similarly, let two Cartesian coordinate systems (X, Y) and (X', Y') differ by a translation: X is parallel to X' and Y to Y', and the origin of the second system coincides with the point (X^0, Y^0) of the first system. The coordinates (X, Y) and (X', Y') of a point are related by

$X = X' + X^0$ $\qquad$ $X' = X - X^0$
$Y = Y' + Y^0$ $\qquad$ $Y' = Y - Y^0$

(Source: Mathworks,2003)

APPENDIX F

EXPORT DATA FROM MICROSOFT ACCESS 2000 TO ARCVIEW GIS 3.3

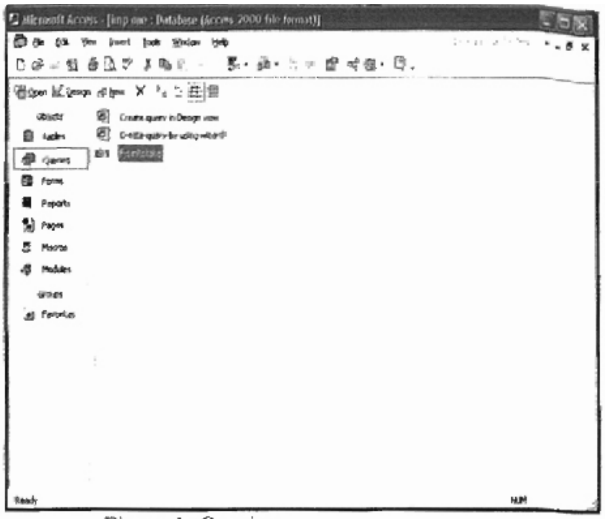


Figure 1: Queries

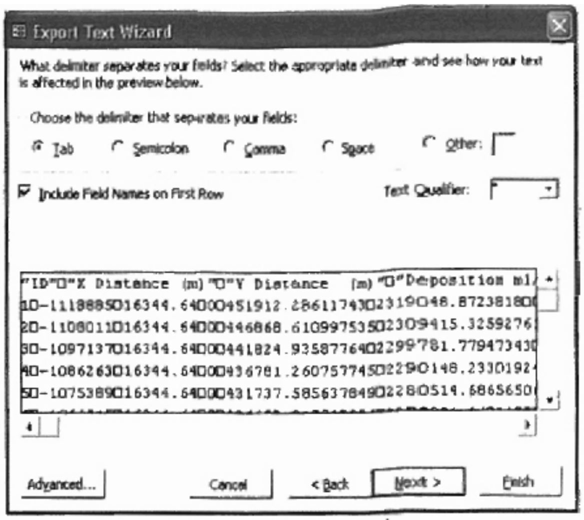


Figure 2: Export Text Wizard

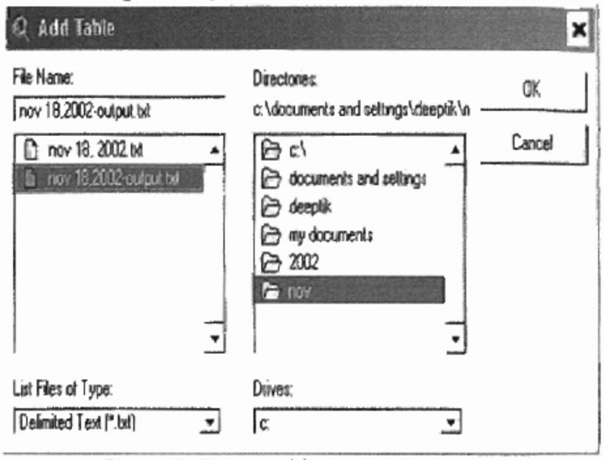


Figure 3: Export table in ArcView

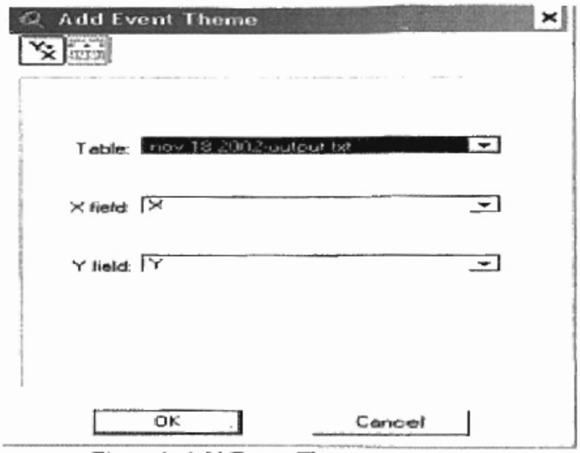


Figure4: Add Event Theme

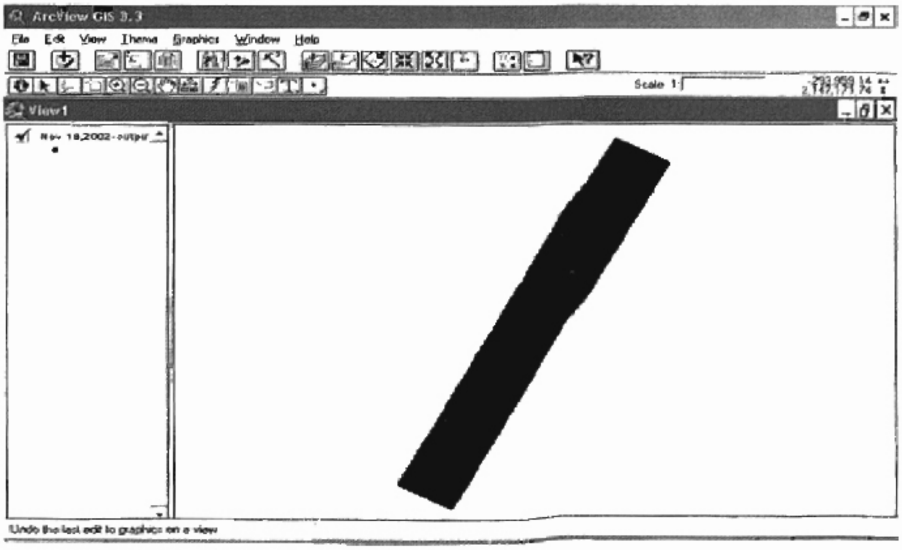


Figure 5: Rectangle consisting of large numbers of points

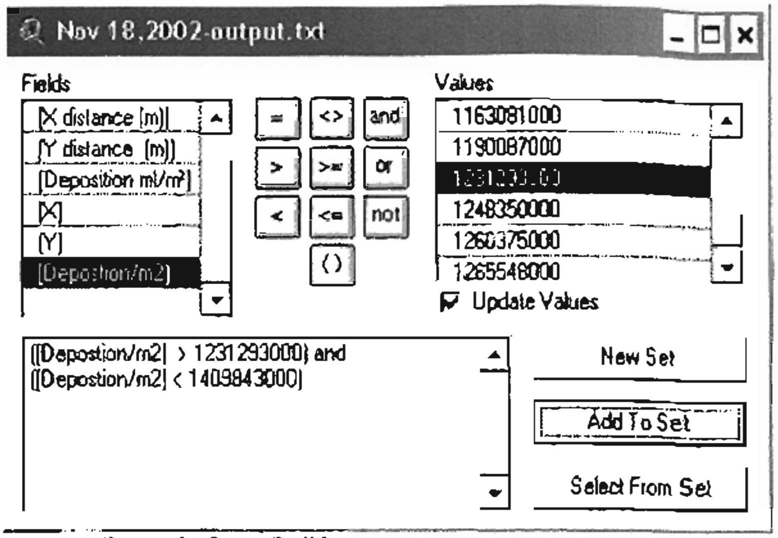


Figure 6: Query Builder

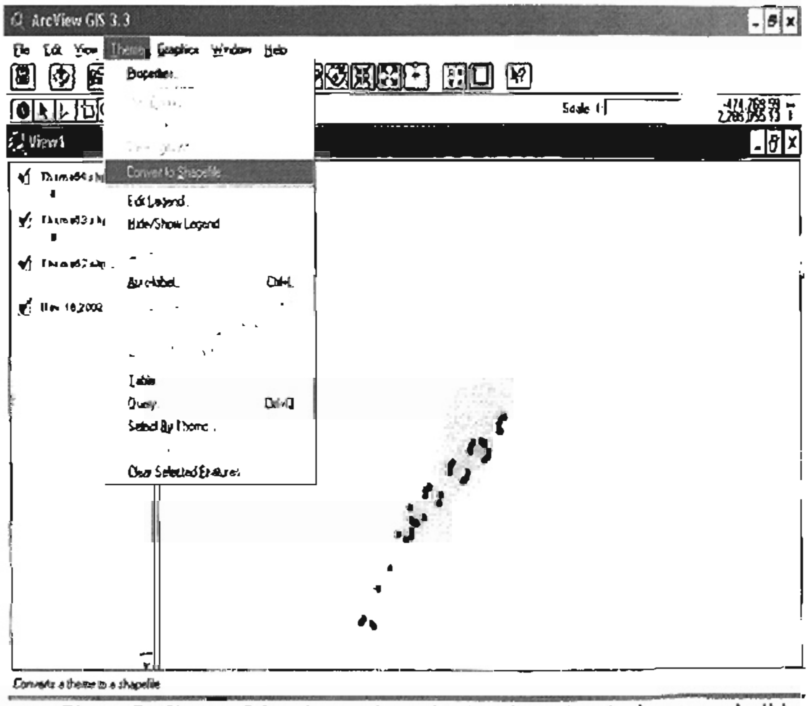


Figure 7: Shape of the plume after selecting the points in the query builder and converting those points to the shapefiles.

APPENDIX G

SUMMARY OF RUNS

Table 1:
Summary of Runs for B-1B

date	Ground level conditio		aircraft condition			Jettison altitude			Results of	jettison run	
	Mean Tem	Wind Spee	Speed	Fuel Jettis	Altitude	Temp	wind spee	Direction	Ground fal	max deposition	
	Celsius	mph	mph	lbs	ft	Celsius	mph	degree	%	ml/m2	mg/m2
1-Jan-96	4.4	16.8	400	12000	20000	-36.1	65.592	227	0.1	1.35E-04	0.13313
2-Jan-96	-0.1	21.3	400	12000	20000	-26.9	31.07	182	0.1	2.60E-04	0.2563985
6-Jan-96	-4.8	18	400	12000	20000	-31.7	84.004	247	0.1	2.42E-04	0.2296
10-Jan-96	7.7	9.8	400	12000	20000	-41.8	44.879	282	0.1	3.38E-04	0.3333181
14-Jan-96	10.2	9.2	400	12000	20000	-15.9	43.728	272	0	1.11E-05	0.0109462
17-Jan-96	13.9	16	400	12000	20000	-22.4	34.522	242	0	3.76E-05	0.0370792
21-Jan-96	4.1	10.7	400	12000	20000	-33	57.537	287	0	2.14E-04	0.2110357
24-Jan-96	2.7	6.7	400	12000	20000	-35.8	117.38	282	0	1.50E-04	0.1479222
27-Jan-96	-0.6	9.3	400	12000	20000	-16.1	44.879	302	0	8.62E-05	0.085006
28-Jan-96	6.4	22.2	400	12000	20000	-19.4	90.909	252	0	5.75E-05	0.0567035
30-Jan-96	-5.3	16.2	400	12000	20000	-18.6	52.934	256	0	1.04E-04	0.1024808
31-Jan-96	-10.3	13.6	400	12000	20000	-20.4	63.291	277	0	2.18E-04	0.2149803
1-Feb-96	-10	10.1	400	12000	20000	-22.4	80.562	252	0	1.78E-04	0.1759288
3-Feb-96	-14.5	13.3	400	12000	20000	-28.9	57.537	262	2	6.01E-04	0.5930695
8-Feb-96	14.4	9.4	400	12000	20000	-19.9	63.291	282	0.1	9.82E-05	0.0968397
11-Feb-96	6.9	16.5	400	12000	20000	-19.9	63.291	277	0.1	1.40E-04	0.1384552
14-Feb-96	15.8	6.9	400	12000	20000	-17.4	41.427	282	0	8.45E-05	0.0836066
17-Feb-96	7.7	13.3	400	12000	20000	-18.3	66.743	312	0	1.81E-04	0.1784928
20-Feb-96	16.1	10.2	400	12000	20000	-29.3	66.743	312	0	1.03E-05	0.0101277
22-Feb-96	21.9	10	400	12000	20000	-15.8	55.236	262	0	1.20E-05	0.0118338
26-Feb-96	20.5	12.2	400	12000	20000	-18.1	90.909	207	0	1.33E-05	0.0131158
28-Feb-96	-0.9	20.4	400	12000	20000	-23.7	101.27	237	1	2.12E-04	0.2090634
1-Mar-96	3	8.5	400	12000	20000	-32.4	58.839	252	0.5	2.34E-04	0.2307587
4-Mar-96	14.4	17.1	400	12000	20000	-23.1	46.03	272	0	9.08E-05	0.0895422
7-Mar-96	-5.9	24.1	400	12000	20000	-31.8	38.125	392	1.5	3.05E-04	0.3008736
9-Mar-96	-2.3	5.5	400	12000	20000	-31.9	57.537	312	1	5.59E-04	0.5512568
14-Mar-96	20.7	15.5	400	12000	20000	-22.4	29.919	207	0	3.31E-05	0.0326415
18-Mar-96	10.5	18.2	400	12000	20000	-28.1	19.563	207	0.5	2.88E-04	0.2840107
22-Mar-96	12.7	9.7	400	12000	20000	-22.6	42.577	302	0	1.43E-04	0.1410192
27-Mar-96	2.2	6.8	400	12000	20000	-20.8	59.839	242	0	1.30E-04	0.1281993
29-Mar-96	11.4	12.7	400	12000	20000	-20.7	34.522	207	0	8.33E-05	0.0821461
31-Mar-96	8	18.9	400	12000	20000	-21.8	46.03	277	0	8.27E-05	0.0815544
1-Apr-96	11.1	7.8	400	12000	20000	-21.5	46.03	322	0	9.44E-05	0.0930924
3-Apr-96	17.7	19.6	400	12000	20000	-17.8	13.809	232	0	5.13E-05	0.0505894
6-Apr-96	8	6.9	400	12000	20000	-23.7	14.96	292	0	1.81E-04	0.1784928
9-Apr-96	16.3	7.5	400	12000	20000	-18.6	44.879	322	0	6.22E-05	0.0613384
11-Apr-96	21.9	20.7	400	12000	20000	-17.4	28.769	277	0	7.55E-06	0.0074454
15-Apr-96	10.5	21.2	400	12000	5000	-0.3	55.236	342	5	1.57E-03	1.5458885
20-Apr-96	16.9	10	400	12000	20000	-19.3	70.195	252	0	6.79E-05	0.0669595
24-Apr-96	19.2	18.3	400	12000	20000	-16.3	56.388	307	0	6.91E-05	0.0681626
28-Apr-96	18	16.6	400	12000	20000	-15	58.688	212	0	3.74E-06	0.0036882
30-Apr-96	13.3	11.3	400	12000	20000	-18.5	85.155	282	0	7.72E-05	0.0761308
1-May-96	17.2	8.6	400	12000	20000	-19	60.989	272	0	7.57E-05	0.0746514
3-May-96	23	12.7	400	12000	20000	-14.8	41.427	262	0	1.30E-05	0.0128199
6-May-96	23.5	9.1	400	12000	20000	-12.8	8.0552	254	0	4.18E-04	0.4122099
9-May-96	23.6	19.5	400	12000	20000	-23.1	14.96	117	0	1.02E-05	0.0100784
11-May-96	14.1	13.1	400	12000	20000	-23.1	41.427	287	0	1.13E-05	0.0111435
15-May-96	25.5	18.3	400	12000	20000	-14.4	13.809	282	0	7.30E-06	0.0071989
20-May-96	26.6	18.6	400	12000	20000	-7.4	28.769	262	0	4.60E-06	0.0045363
24-May-96	26.9	15.8	400	12000	20000	-12.2	40.276	172	0	5.85E-06	0.005769
29-May-96	18.1	9.7	400	12000	20000	-12.2	50.633	272	0	1.36E-05	0.0134116
31-May-96	23.3	10.2	400	12000	20000	-13.7	10.357	147	0	1.75E-05	0.0172576
2-Jun-96	22.2	4.8	400	12000	20000	-14.8	33.371	292	0	5.93E-05	0.0584786
5-Jun-96	24.4	11.3	400	12000	20000	-14.1	33.371	307	0	7.50E-06	0.0073961
8-Jun-96	18.6	13.2	400	12000	20000	-16.4	86.607	307	0	3.64E-05	0.0358958
11-Jun-96	23.8	7.3	400	12000	20000	-10.4	23.015	317	0	2.67E-05	0.0263302
14-Jun-96	26.7	7.3	400	12000	20000	-7.5	6.9044	102	0	4.33E-05	0.0427002
18-Jun-96	29.4	9	400	12000	20000	-18.1	10.357	287	0	3.03E-05	0.0298803
22-Jun-96	26.2	8.9	400	12000	20000	-7.4	18.11	232	0	1.61E-05	0.015877
27-Jun-96	28.3	10.4	400	12000	20000	-3.6	13.809	162	0	8.50E-06	0.0083884
29-Jun-96	29.7	9.2	400	12000	20000	-4.7	24.166	112	0	1.91E-05	0.0188354
1-Aug-96	24.5	8.0	400	12000	20000	-6	16.11	287	0	1.29E-05	0.0127213
3-Aug-96	24.5	11.3	400	12000	20000	-8.5	49.482	302	0	6.85E-06	0.0067551
5-Aug-96	30	15.5	400	12000	20000	-4.9	19.563	172	0	5.25E-06	0.0051773
6-Aug-96	28	13.2	400	12000	20000	-7.2	14.96	157	0	5.90E-06	0.0058183
8-Aug-96	27	9.1	400	12000	20000	-8.3	8.0552	192	0	2.53E-05	0.0249495
10-Aug-96	24.5	7.7	400	12000	20000	-8.1	42.577	252	0	1.87E-05	0.0184114
12-Aug-96	22	7.9	400	12000	20000	-8.1	42.577	2	0	1.51E-05	0.0148908
15-Aug-96	25.5	7.1	400	12000	20000	-9.8	32.221	357	0	1.41E-05	0.0138948
17-Aug-96	25.5	5.8	400	12000	20000	-7.2	14.96	157	0	5.11E-06	0.0050392
18-Aug-96	27	8.9	400	12000	20000	-8.2	14.96	307	0	1.83E-05	0.0180465
1-Sep-96	24.5	5.6	400	12000	20000	-11.8	13.809	326	0	6.38E-05	0.0629162
3-Sep-96	23.5	7.6	400	12000	20000	-11.2	5.7537	7	0	1.83E-05	0.0180465
5-Sep-96	26.5	8	400	12000	20000	-9	19.563	97	0	2.47E-05	0.0243579
7-Sep-96	26	9.1	400	12000	20000	-7.8	16.11	237	0	2.34E-05	0.0230759
10-Sep-96	27	4.5	400	12000	20000	-11.3	21.864	12	0	2.16E-05	0.0213008
12-Sep-96	23.5	6	400	12000	20000	-10.3	24.166	257	0	2.74E-05	0.0270205
16-Sep-96	19	11.7	400	12000	20000	-8	35.673	292	0	1.90E-05	0.0187072
21-Sep-96	18.5	6.1	400	12000	20000	-10.8	62.14	307	0	3.83E-05	0.0377695
26-Sep-96	16	17	400	12000	20000	-9.7	51.783	222	0	9.97E-06	0.0098319
29-Sep-96	17.5	7.8	400	12000	20000	-10.6	26.467	307	0	2.41E-05	0.0237662
1-Oct-96	18.5	12	400	12000	20000	-9.5	10.357	307	0	2.30E-05	0.0226814
5-Oct-96	17.5	7.1	400	12000	20000	-13.4	9.2059	192	0	3.38E-05	0.0333614
8-Oct-96	16	11.2	400	12000	20000	-13.5	58.688	337	0	6.05E-05	0.059662
11-Oct-96	16.5	11.4	400	12000	20000	-11.9	12.658	312	0	2.00E-05	0.019723
14-Oct-96	19	13.8	400	12000	20000	-14.1	34.522	212	0	2.09E-05	0.0206106
18-Oct-96	11	8.3	400	12000	20000	-14.7	71.346	292	0	7.04E-05	0.0694248
21-Oct-96	14.5	12.5	400	12000	20000	-16.8	47.18	217	0	4.11E-05	0.0405307
24-Oct-96	14.5	12	400	12000	20000	-19.9	46.03	222	0	6.68E-05	0.0658747
28-Oct-96	10.5	8.4	400	12000	20000	-10.3	41.427	247	0	3.05E-05	0.0300775
30-Oct-96	13	8.1	400	12000	20000	-15.6	58.688	262	0	3.34E-05	0.0329373
4-Nov-96	14	16	400	12000	20000	-15.2	73.647	212	0	3.38E-05	0.0333614
11-Nov-96	8	9	400	12000	20000	-16.8	57.537	312	0	6.17E-05	0.0608453
13-Nov-96	8	6.8	400	12000	20000	-15	31.07	262	0	6.50E-05	0.0640996
15-Nov-96	14.6	14.8	400	12000	20000	-19	51.783	202	0.1	4.82E-05	0.0475323
17-Nov-96	6	12.4	400	12000	5000	2.8	35.673	317	4	2.62E-03	2.5866665
20-Nov-96	15	8.4	400	12000	20000	-11.6	49.482	292	0	1.75E-05	0.0172576
23-Nov-96	14	15.8	400	12000	20000	-15	43.728	222	0	1.06E-05	0.0104532
25-Nov-96	-0.5	20.9	400	12000	20000	-21.4	28.769	327	0.1	1.21E-04	0.1189295
27-Nov-96	0.5	6.4	400	12000	20000	-21.3	56.386	237	0.1	1.56E-04	0.1537405
30-Nov-96	5.5	9.6	400	12000	20000	-23.7	84.004	217	0	7.57E-05	0.0746514

Cont'd...Table 1

date	Ground level conditio		aircraft condition			jettison altitude			Results of jettison run		
	Mean Tem	Wind Spee	Speed	Fuel Jettis	Altitude	Temp	wind spee	Direction	Ground fal	max deposition	
	Celsius	mph	mph	lbs	ft	Celsius	mph	degrees	%	ml/m2	mg/m2
1-Jan-97	15	9.7	402.76	12000	20000	-13.5	33.371	0	0.1	4.67E-05	0.04604325
5-Jan-97	7.5	13.2	402.76	12000	20000	-19.4	96.662	270	0.1	9.62E-05	0.09486745
6-Jan-97	0	7.3	402.76	12000	20000	-25.5	94.361	217	0.2	1.62E-04	0.15975996
15-Jan-97	0.5	19.6	402.76	12000	20000	-27.9	118.63	212	0.2	1.07E-04	0.10551785
16-Jan-97	-2.5	15.7	402.76	12000	20000	-24.1	56.385	267	0.1	1.66E-04	0.16409504
21-Jan-97	15.5	21.3	402.76	12000	20000	-18	31.07	207	0.1	3.42E-05	0.03372627
23-Jan-97	11	9.3	402.76	12000	20000	-19.4	64.441	232	0	8.18E-05	0.08066691
27-Jan-97	1.5	17.1	402.76	12000	20000	-21.1	59.839	242	0	5.49E-05	0.05413931
29-Jan-97	0	8.7	402.76	12000	20000	-22.7	9.2059	257	0.1	2.95E-04	0.29094139
1-Feb-97	12.5	5.3	402.76	12000	20000	-14.6	28.769	357	0	7.00E-06	0.00690333
4-Feb-97	10	16	402.76	12000	20000	-19.9	75.949	257	0	6.60E-05	0.06508571
8-Feb-97	-1.5	13.6	402.76	12000	20000	-23.1	82.853	272	0.5	3.04E-04	0.2996084
10-Feb-97	2.5	6.9	402.76	12000	20000	-26.2	35.673	297	0.4	3.36E-04	0.33124336
15-Feb-97	1	16.4	402.76	12000	20000	-27.4	56.386	302	0.1	2.05E-04	0.20200175
18-Feb-97	13.5	20.8	402.76	12000	20000	-17.1	40.276	237	0	1.51E-05	0.01489084
23-Feb-97	8	7.6	402.76	12000	20000	-25.8	71.346	257	0.1	1.91E-04	[illegible]
26-Feb-97	5	8.4	402.76	12000	20000	-18.2	87.456	232	0	6.54E-05	0.06450395
28-Feb-97	10	12.4	402.76	12000	20000	18.9	64.441	227	0	6.03E-05	0.05946473
1-Mar-97	11	12.4	402.76	12000	20000	-29.4	75.949	217	0	5.09E-05	0.0502048
3-Mar-97	10.5	19.8	402.76	12000	20000	-15.8	56.386	247	0	6.07E-05	0.05984019
6-Mar-97	6.5	18.3	402.76	12000	20000	-23.3	62.14	267	0	1.21E-04	0.11922511
10-Mar-97	12	7.3	402.76	12000	20000	-18.2	40.276	262	0	9.49E-05	0.09358845
12-Mar-97	16.5	10.2	402.76	12000	20000	-18.3	19.563	102	0	4.96E-05	0.04891295
20-Mar-97	15	6.7	402.76	12000	20000	-16.4	44.879	22	0	4.00E-05	0.03944593
21-Mar-97	21.5	12.9	402.76	12000	20000	-12.7	21.864	307	0	2.02E-05	0.01992015
26-Mar-97	11	6	402.76	12000	20000	-21.5	51.783	37	0	1.37E-04	0.13510229
28-Mar-97	16	19.6	402.76	12000	20000	-20.2	66.743	252	0	4.70E-05	0.04634806
31-Mar-97	11.5	9.6	402.76	12000	20000	-20.7	21.864	252	0	1.57E-04	0.15472664
1-Apr-97	14.5	15.4	402.76	12000	20000				0	4.67E-05	0.04604325
2-Apr-97	16.5	12.4	402.76	12000	20000				0	4.67E-05	0.04604325
3-Apr-97	18.5	9.6	402.76	12000	20000	-19.4	21.864	202	0	8.23E-05	0.0811599
5-Apr-97	16	16.1	402.76	12000	20000	-19.1	102.42	162	0	4.66E-05	0.0459545
8-Apr-97	9.5	13	402.76	12000	20000	-22.1	47.18	227	0	8.08E-05	0.07968077
12-Apr-97	0.5	19.9	402.76	12000	20000	-29.1	49.482	247	0	2.21E-04	0.21793873
16-Apr-97	15	11	402.76	12000	20000	-21.6	19.563	262	0	1.69E-04	0.16705349
22-Apr-97	16.5	13.3	402.76	12000	20000	-17.6	51.783	272	0	9.48E-05	0.09350656
24-Apr-97	12	6.9	402.76	12000	20000	-20.5	26.467	252	0	1.53E-04	0.15127512
26-Apr-97	10.5	11.9	402.76	12000	20000	-17	31.07	237	0	1.16E-04	0.11636548
3-May-97	13	13.5	402.76	12000	20000	-20.1	66.165	277	0	1.53E-04	0.15127512
5-May-97	20	13.3	402.76	12000	20000	-15.2	33.371	267	0	8.51E-06	0.00839212
15-May-97	20	7	402.76	12000	20000	-17.3	42.577	297	0	5.29E-05	0.0521771
21-May-97	20	9.7	402.76	12000	20000	-9.9	26.467	322	0	1.90E-05	0.01872695
5-Jun-97	20	6.6	402.76	12000	20000	-10.6	33.371	342	0	2.07E-05	0.02041377
8-Jun-97	22.5	7	402.76	12000	20000	-12.2	9.2059	242	0	3.38E-05	0.03333186
22-Jun-97	25	15	402.76	12000	20000	-29.4	21.864	97	0	1.01E-04	0.09960006
1-Jul-97	28.5	17	402.76	12000	20000	-5	26.467	310	0	3.27E-06	0.0032247
7-Jul-97	23.5	8.4	402.76	12000	20000	10.7	18.412	312	0	2.34E-05	0.02309559
14-Jul-97	30.5	10.1	402.76	12000	20000	-5.5	9.2059	352	0	1.07E-05	[illegible]
25-Jul-97	29	10.5	402.76	12000	20000	-7	13.809	137	0	9.35E-06	0.00922048
31-Jul-97	24.5	8.2	402.76	12000	20000	-5.5	11.507	37	0	2.11E-05	0.02080771
2-Aug-97	26.5	8.2	402.76	12000	20000	-5.4	6.9044	17	0	1.51E-05	0.01484115
11-Aug-97	25	7.7	402.76	12000	20000	-6.4	20.467	227	0	8.35E-06	0.00823532
17-Aug-97	27.5	13.6	402.76	12000	20000	-10	20.467	257	0	4.81E-06	0.00473844
24-Aug-97	24	8.4	402.76	12000	20000	-8.9	11.507	342	0	2.89E-05	0.02849964
31-Aug-97	28	7.9	402.76	12000	20000	-10.1	13.809	312	0	1.10E-05	0.01084467
1-Sep-97	28	7.1	402.76	12000	20000	-7.1	13.809	357	0	1.30E-05	0.01251398
4-Sep-97	22	8.1	402.76	12000	20000	-6.8	4.603	62	0	3.25E-05	0.03204685
9-Sep-97	28	9.9	402.76	12000	20000	-11.4	42.577	317	0	1.41E-05	0.0138946
17-Sep-97	29	11.6	402.76	12000	20000	-7.8	28.769	247	0	6.52E-06	0.00642969
18-Sep-97	29	18.9	402.76	12000	20000	-6.5	16.11	252	0	5.88E-06	0.00579461
23-Sep-97	20.5	8.9	402.76	12000	20000	-8.2	42.577	207	0	9.51E-06	0.00937925
26-Sep-97	19.5	4.7	402.76	12000	20000	-7.8	4.603	47	0	2.06E-05	0.02031465
2-Oct-97	25	13.9	402.76	12000	20000	-11.4	6.9044	137	0	1.87E-05	0.01844097
5-Oct-97	23	13.1	402.76	12000	20000	-6.6	11.507	147	0	1.59E-05	0.01567971
10-Oct-97	23.5	8.3	402.76	12000	20000	-8.8	16.11	162	0	2.65E-05	0.02613202
13-Oct-97	12.5	13.9	402.76	12000	6000	4.8	40.276	327	1	1.03E-03	1.01186657
17-Oct-97	14	7.7	402.76	12000	20000	-20.5	21.864	302	0	1.22E-04	0.12044813
24-Oct-97	14	6.7	402.76	12000	20000	-20	54.085	242	0	5.37E-05	0.05297569
30-Oct-97	18	14	402.76	12000	20000	-17.6	28.769	252	0	3.49E-05	[illegible]
2-Nov-97	13	13.8	402.76	12000	20000	-29.4	87.456	297	0	1.11E-04	0.10946244
8-Nov-97	11	10.1	402.76	12000	20000	-13.6	19.563	197	0	8.09E-05	[illegible]
10-Nov-97	7.6	16.2	402.76	12000	20000	-28	21.684	277	0.5	3.42E-04	0.33726265
16-Nov-97	0	5.3	402.76	12000	20000	-24.6	75.949	282	0.2	2.43E-04	0.23961499
21-Nov-97	8	8.7	402.76	12000	20000	-25.9	37.974	257	0.1	2.43E-04	0.23963799
29-Nov-97	13.5	13.2	402.76	12000	20000	-15.0	59.839	272	0	2.15E-05	0.02120319
1-Dec-97	8	8.5	402.76	12000	20000	-18.2	28.769	247	0	1.82E-04	0.17947899
8-Dec-97	-0.5	9.8	402.76	12000	20000	28.2	89.652	282	0	1.37E-04	0.13472151
9-Dec-97			402.76	12000	20000					1.37E-04	0.13472151
16-Dec-97	8	9.8	402.76	12000	20000	-13.6	13.809	317	0	1.02E-04	0.10058295
20-Dec-97	6.5	15.5	402.76	12000	20000	-19.3	96.380	192	0	1.06E-04	0.10482754
22-Dec-97	2.5	18.9	402.76	12000	20000	-21.7	33.371	267	0	1.83E-04	0.18078085
23-Dec-97	2.5	10.5	402.76	12000	20000	22.2	51.783	237	0	1.23E-04	0.12139672
27-Dec-97	2	10.5	402.76	12000	20000	27.7	44.879	237	0	2.61E-04	0.25718465
29-Dec-97	4.5	17	402.76	12000	20000	-30.5	97.613	322	0.2	2.97E-04	0.29268599
31-Dec-97	4	10.4	402.76	12000	20000	-20.6	73.647	307	0	1.34E-04	0.13214385
1-Jan-98	9	20.8	400	12000	20000	-19.5	28.789	262	0	7.85E-05	0.0774128
4-Jan-98	8	12.3	375	12000	20000	-22.6	56.386	212	0	1.95E-04	0.193285
7-Jan-98	1	21.5	375	12000	20000	-22.7	26.46	152	0	1.24E-04	0.1222824
9-Jan-98	2.5	8.2	400	12000	20000	-22.3	44.879	265	0	1.60E-04	0.1577837
13-Jan-98	-2	12.2	350	14000	20000	-26.2	9.28	217	0	3.22E-05	0.031754
14-Jan-98	-2	7.6	350	14000	20000	-27.4	28.76	252	0	5.76E-04	0.5680213
20-Jan-98	10.6	20.6	350	14000	5000	-21.3	71.34	244	4	2.11E-04	0.2080772
26-Jan-98	8.5	15.1	350	14000	20000	-23.1	51.63	242	0.1	8.66E-04	0.8540043
26-Jan-98	7.5	10.2	400	12000	20000	-19.5	61.783	267		9.61E-05	0.0947588
28-Jan-98	10.5	12.4	350	12000	20000	-18.4	61.78	282	0	2.49E-05	0.0245551
29-Jan-98	7.5	6.3	400	12000	20000	-25.3	28.78	297	0	1.26E-04	0.1242647
31-Jan-98	10.5	9.8	400	12000	6000	5.6	18.412	192	2	8.76E-04	0.8638957
1-Feb-98	9.5	9.4	345	12000	20000	-28	21.86	257	0	4.60E-05	0.0453628
4-Feb-98	2.5	10.6	400	12000	6000	-0.8	4.603	32	3	0.0053231	5.249355
5-Feb-98	1.5	9.4	350	12000	20000	-25.4	18.1098	177	1	4.23E-04	0.4171405
8-Feb-98	7	6	400	12000	20000	-29.6	13.809	227	0	3.81E-04	0.3757224
9-Feb-98	8.5	10.8	350	12000	20000	-27.5	42.57	237	0	5.25E-05	0.0517728
15-Feb-98	10.5	11	345	12000	20000	-22.2	31.06	152	0.1	4.33E-04	0.4270021
19-Feb-98	10	8.3	345	12000	20000	-30.2	9.71	242	3	8.17E-04	0.805683
23-Feb-98	11.5	8.2	400	12000	20000	-24.3	75.99	287	0	1.58E-04	0.1558114
24-Feb-98	15	10.4	350	12000	20000	-17.7	59.83	257	0.1	2.91E-05	0.0286969
25-Feb-98	19	20.9	350	12000	5000	18.1	27.51	257	1	4.44E-04	0.4378498
27-Feb-98	8	9.2	350	12000	20000	-30.2	56.38	242	1	1.12E-04	0.1104486
28-Feb-98	6	11.4	400	12000	20000	-36.2	24.166	287	0.5	2.04E-04	0.2011742
9-Mar-98	2	21.5	350	12000	20000	-28.4	62.13	212	2	8.34E-05	0.0822448
10-Mar-98	-3	12	350	12000	20000	-28.9	82.85	282	2	5.92E-04	0.5837997
11-Mar-98	-1	10.7	350	12000	20000	-28.2	80.5	292	1	1.02E-04	0.1005871
12-Mar-98	-3	10.4	350	12000	20000	-21.6	80.5	292	1	6.00E-04	0.5916889
16-Mar-98	11	15.1	350	12000	20000	-17.1	47.17	180	0	2.98E-05	0.0293872
18-Mar-98	8.5	5.9	375	11000	20000	-25.3	29.91	254	0.1	2.08E-04	0.2051188
25-Mar-98	20	17	375	11000	20000	-26.1	49.48	270	0.1	6.87E-04	0.6774837
16-Mar-98	11	15.1	350	12000	20000	-17.1	47.17	180	0	2.98E-05	0.0293872
18-Mar-98	8.5	5.9	375	11000	20000	-25.3	29.91	254	0.1	2.08E-04	0.2051188
18-Mar-98	8.5	5.9	375	11000	20000	-25.3	29.91	254	0.1	2.08E-04	0.2051188
25-Mar-98	20	17	375	11000	20000	-26.1	49.48	270	0.1	6.87E-04	0.6774837
28-Mar-98	19.5	12.4	375	11000	20000	-18.1	69.63	250	0.1	2.32E-05	0.0228786

date	Ground level conditio		aircraft condition			Jettison altitude			Results of jettison run		
	Mean Tem	Wind Spe	Speed	Fuel Jettis	Altitude	Temp.	wind spee	Direction	Ground fa	max deposition	
	Celsius	mph	mph	lbs	ft	Celsius	mph	degree	%	ml/m2	mg/m2
1-Apr-98	18	11.8	375	11000	20000	-24.1	69.042	267	0.1	2.66E-05	0.0264288
2-Apr-98	17	10	400	12000	20000	-19	49.482	222	0	3.61E-05	0.0356030
4-Apr-98	9	12.3	350	12000	20000	-17.9	54.38	33	0	5.33E-04	0.5256169
5-Apr-98	18	15.2	400	12000	20000	-18.6	49.482	222	0	3.76E-05	0.0370792
8-Apr-98	14	13.8	350	12000	20000	-24.5	109.15	232	0.1	5.33E-04	0.5256169
12-Apr-98	19	22	350	12000	20000	-13.3	69.042	247	0	7.80E-04	0.7691955
14-Apr-98	21	13.1	400	12000	20000	-20.8	49.482	247	0	1.90E-05	0.0187368
16-Apr-98	12.5	27.2	350	12000	20000	-15.9	109.31	242	0	5.10E-04	0.5029355
19-Apr-98	15.5	4.8	400	12000	6000	3.2	11.507	267	0.5	0.000879	0.8532318
20-Apr-98	13.5	10.1	350	12000	20000	-22.1	28.76	297	0.1	4.50E-04	0.4437646
22-Apr-98	16	9.2	400	12000	20000	-25.9	51.783	357	0	1.16E-04	0.1144689
24-Apr-98	20	15.7	350	12000	20000	-16.1	25.466	322	0.1	5.33E-04	0.5256169
25-Apr-98	23	21.4	350	12000	20000	-10.7	31.97	277	0	5.33E-04	0.5256169
27-Apr-98	13	15.2	400	12000	20000	-20.5	21.864	347	0	7.41E-05	0.07304
2-May-98	20.5	7.7	350	12000	20000	19.4	28.76	310	0	1.90E-05	0.0187368
4-May-98	10.8	7.8	350	12000	20000	17.9	51.78	305	0	2.01E-05	0.0198216
6-May-98	21	8.7	350	12000	20000	-13.7	62.13	275	0	3.40E-06	0.0033529
7-May-98	19	6.5	350	12000	20000	12.1	78.24	275	0	1.78E-06	0.0017553
10-May-98	18	6.5	350	12000	20000	-18.1	37.97	287	0	2.17E-05	0.0213994
13-May-98	23	14.4	350	12000	20000	-17.2	69.75	212	0	3.50E-06	0.0034515
15-May-98	23	14.4	350	12000	20000	-12.2	69.75	212	0	3.50E-06	0.0034515
18-May-98	26.5	10.4	350	12000	20000	-15.1	26.46	272	0	6.70E-06	0.0065795
24-May-98	25	7.8	350	12000	20000	-14.9	33.37	222	0	2.27E-05	0.0223856
24-May-98	25	7.8	350	12000	20000	-14.9	33.37	222	0	2.27E-05	0.0223856
2-Jun-98	32.5	13.8	350	12000	20000	-1.4	31.06	287	0	3.64E-06	0.0035896
5-Jun-98	26.7	18.4	350	12000	20000	-11.5	67.45	237	0	5.40E-06	0.0053252
5-Jun-98	26.7	18.4	350	12000	20000	-11.5	67.45	237	0	5.40E-06	0.0053252
7-Jun-98	18.5	10.5	400	12000	20000	-14.3	42.577	282	0	2.08E-05	0.0204623
10-Jun-98	27.2	20	350	12000	20000	-10.9	26.46	247	0	7.68E-06	0.0075730
16-Jun-98	24	8.6	350	12000	20000	-18.3	26.46	247	0	5.23E-04	0.5157555
20-Jun-98	32	21.2	325	14000	20000	-6.0	28.76	287	0	2.88E-06	0.0028387
24-Jun-98	35	23.6	350	12000	20000	-8	11.507	302	0	9.26E-08	0.0001733
27-Jun-98	26.7	14.3	350	12000	20000	-4.6	4.6096	67	0	8.70E-06	0.0099072
1-Jul-98	28	12.8	350	12000	20000	-9.5	10.5616	242	0	6.87E-04	0.6773452
3-Jul-98	30	13.7	300	15000	20000	-6.8	11.507	207	0	7.11E-06	0.0070115
3-Jul-98	30	13.7	300	15000	20000	-6.8	11.507	207	0	7.11E-06	0.0070115
7-Jul-98	33.6	11.7	250	15000	20000	-9.8	9.0256	212	0.5	4.83E-04	0.4763095
10-Jul-98	32.5	15.3	400	10000	20000	-5.9	13.806	207	0	7.07E-06	0.0069721
15-Jul-98	28.9	7.1	375	10000	20000	-8.5	11.507	52	0	1.00E-05	0.0098815
18-Jul-98	30.6	8.1	400	12000	20000	-8.3	9.2056	87	0	3.37E-05	0.0332332
22-Jul-98	31.6	11.3	400	12000	20000	-8.3	9.2056	272	0	1.05E-05	0.0103548
28-Jul-98	43.4	14.2	350	12000	20000	-7.7	16.1	271	0	6.49E-06	0.0064001
3-Aug-98	31.5	8.8	350	12000	20000	-8.2	18.411	242	0	6.14E-06	0.0060272
4-Aug-98	37	7	400	12000	20000	-8.2	28.768	242	0	2.82E-05	0.0278084
12-Aug-98	27	6	345	12000	20000	-8.4	11.507	307	0	4.23E-05	0.0417141
17-Aug-98	30	10	345	12000	20000	-8.8	9.2	72	0	1.20E-05	0.0118338
19-Aug-98	31	5.8	345	12000	20000	-8	13.8	137	0	1.35E-05	0.013313
24-Aug-98	30	9.8	345	12000	20000	-4.4	9.2056	77	0	1.01E-05	0.0099601
28-Aug-98	32	8.2	345	12000	20000	-5.6	9.2056	167	0	6.99E-06	0.0068935
31-Aug-98	31.5	8.3	350	12000	20000	-6.6	11.507	352	0	2.11E-05	0.0208077
3-Sep-98	32	7	400	12000	20000	-6.4	16.11	357	0	9.80E-06	0.0096647
4-Sep-98	32	5.3	400	12000	20000	-6.2	16.11	322	0	4.27E-06	0.0042109
8-Sep-98	31.5	11.9	400	12000	20000	7.4	11.507	52	0	8.67E-06	0.0085361
10-Sep-98	24.5	9.3	400	12000	20000	-8.2	6.9044	142	0	9.83E-06	0.0096938
14-Sep-98	20	7.6	400	12000	20000	-6.9	11.507	202	0	1.11E-05	0.0109482
25-Sep-98	28	14.7	400	12000	20000	-6.7	18.412	257	0	4.33E-06	0.0042671
4-Oct-98	24.5	14.7	400	12000	20000	-12.8	28.769	107	0	9.34E-06	0.0092106
6-Oct-98	18.5	4.8	400	12000	20000	-10	33.371	312	0	2.14E-05	0.0211134
12-Oct-98	18.5	4.8	400	12000	6000	11.8	9.2056	27	0.2	1.19E-03	1.1777567
19-Oct-98	15	6.3	400	12000	6000	9.1	18.412	322	0.1	1.50E-03	1.4790240
27-Oct-98	12	6.1	400	12000	6000	7.4	16.11	27	0	1.55E-03	1.531488
28-Oct-98	19	11.7	400	12000	20000	14.8	19.563	187	0	4.79E-04	0.4723840
29-Oct-98	21	13.1	400	12000	20000	11.2	50.639	232	0	9.88E-06	0.0097431
31-Oct-98	20.5	8.7	400	12000	6000	17.2	21.864	182	0	4.63E-04	0.4565606
6-Nov-98	6	6.3	400	12000	6000	1.3	13.809	187	5	7.64E-03	7.5316047
8-Nov-98	6	8.3	400	12000	6000	8	18.412	242	1.5	2.86E-03	2.8463284
11-Nov-98	9.5	10.6	400	12000	6000	1.6	19.563	242	1.5	1.18E-03	1.1617611
18-Nov-98	17.5	18.2	400	12000	6000	14.2	47.15	232	0.5	5.14E-04	0.5068801
27-Nov-98	15	11.7	400	12000	6000	13.2	18.412	232	0.1	7.28E-04	0.71782
28-Nov-98	19	17.8	400	12000	6000	10.9	40.276	212	0.1	3.97E-04	0.3915008
2-Dec-98	12	14.3	350	12000	20000	-9.7	33.37	232	0	5.80E-06	0.0057197
3-Dec-98	18	14.4	345	12000	20000	-10.7	33.37	212	0	4.43E-04	0.4368830
6-Dec-98	12.5	14.8	345	12000	20000	-13.1	18.56	251	0	1.50E-05	0.0147822
15-Dec-98	9	8.9	350	12000	20000	-17.9	18.56	42	0	1.75E-04	0.1725750
18-Dec-98	9	18.9	350	12000	20000	-12.7	59.63	232	0.1	2.12E-05	0.0209063
21-Dec-98	-3.5	16	345	12000	20000	-16.1	62.65	242	0	4.80E-04	0.4733511
23-Dec-98	-7	9.2	345	12000	20000	-16.7	64.35	237	0.1	5.00E-04	0.4930741
15-Dec-98	9	8.9	350	12000	20000	-17.9	18.56	42	0	1.75E-04	0.1725750
18-Dec-98	9	18.9	350	12000	20000	-12.7	59.63	232	0.1	2.12E-05	0.0209063
21-Dec-98	-3.5	16	345	12000	20000	-16.1	62.65	242	0	4.80E-04	0.4733511
23-Dec-98	-7	9.2	345	12000	20000	-16.7	64.35	237	0.1	5.00E-04	0.4930741
3-Jan-99	-7.5	20	350	12000	20000	-22.3	71.49	237	1	1.23E-04	0.1212962
4-Jan-99	-4.5	5.2	400	12000	20000	-38.5	50.639	282	1.5	3.29E-04	0.3244427
8-Jan-99	-4	12.5	275	16000	20000	-20.7	57.535	232	1	3.33E-04	0.3283873
9-Jan-99	-8.5	13.9	400	12000	20000	-28.4	40.278	282	0.5	2.87E-04	0.2830245
15-Jan-99	8	16.8	350	12000	20000	-17.1	37.073	257	0	6.72E-05	0.0662607
19-Jan-99	11	14.6	400	12000	20000	-18.6	84.441	257		3.02E-05	0.0298113
20-Jan-99	11.5	6	250	16000	20000	-13.9	49.48	282	2	8.41E-04	0.8321208
26-Jan-99	11	13.3	300	15000	20000	-11.3	82.12	217	0	4.76E-05	0.0469408
1-Feb-99	8	10.6	250	15000	20000	-19.8	44.87	242	2	8.44E-04	0.8320794
6-Feb-99	16	12.6	300	14000	20000	-14.3	71.34	243	0	6.94E-06	0.0068436
13-Feb-99	7	7.1	350	12000	20000	-14.3	28.46	212	0	3.00E-04	0.3047190
15-Feb-99	13	20.3	300	14000	20000	-14.3	42.97	252	0	8.17E-05	0.0808453
21-Feb-99	3	12.2	300	14000	20000	-15.3	84.35	302	1	2.61E-04	0.2573847
23-Feb-99	7	10.6	300	14000	20000	-29.1	58.88	282	1	2.30E-04	0.2288141
1-Mar-99	0.5	11.9	350	12000	20000	-28.8	48.32	282	0	6.30E-05	0.0622442
5-Mar-99	16.5	10.9	350	12000	20000	-33	56.68	257	0	4.34E-05	0.0427988
13-Mar-99	7	16.5	300	14000	20000	-23.5	64.43	288	2	4.84E-04	0.4772057
15-Mar-99	7.5	8.5	300	14000	20000	-18.1	31.08	302	0	5.00E-04	0.4930741
17-Mar-99	15.5	16.8	300	14000	20000	17	31.08	237	0.1	4.90E-05	0.0483213
23-Mar-99	13	18	350	12000	20000	-17.1	42.87	282	0.1	1.80E-05	0.0177607
28-Mar-99	9	10.4	350	12000	20000	-24.5	35.87	222	0	6.00E-05	0.0591689
1-Apr-99	18	20.3	400	12000	20000	-18.4	33.371	212	0	1.15E-05	0.0113407
8-Apr-99	15.5	8.2	400	12000	20000	-18.8	40.276	257	0	1.53E-05	0.0150534
15-Apr-99	11	28.5	400	12000	20000	-22.2	13.809	77	0	1.34E-04	0.1321438
24-Apr-99	10.5	14.4	400	12000	20000	-13.2	42.577	227	0	3.00E-05	0.0295644
27-Apr-99	17	7.3	400	12000	20000	-24.2	44.879	242	0	7.85E-05	0.0774128
29-Apr-99	15.5	11.3	400	12000	20000	-14.9	18.412	227	0	2.04E-04	0.2011742
1-May-99	18.5	9.4	400	12000	20000	-14.4	24.168	167	0	8.30E-05	0.0818500
4-May-99	20.5	20.7	400	12000	20000	-18.4	59.839	217	0	2.02E-05	0.0199202
8-May-99	27	14.2	400	12000	20000	-15	19.563	277	0	1.04E-05	0.0102757
14-May-99	21	11.9	400	12000	20000	-14	24.166	237	0	1.62E-05	0.0159764
18-May-99	16.5	8.4	400	12000	20000	-15.1	64.441	282	0	2.60E-05	0.0256357
23-May-99	23	10.7	400	12000	20000	-11.4	42.577	237	0	1.65E-05	0.0162714
1-Jun-99	25	11.6	400	12000	20000	13.8	44.879	247	0	5.38E-06	0.0053025
6-Jun-99	26	14.3	400	12000	20000	-12.5	31.07	227	0	4.73E-06	0.0046646
7-Jun-99	25	9.3	400	12000	20000	-11.5	9.2056	152	0	1.33E-05	0.0131168
18-Jun-99	21.5	9.3	400	12000	20000	-11.5	28.769	282	0	1.23E-05	0.0121286
20-Jun-99	24	7	400	12000	20000	-9.3	6.9044	62	0	2.08E-05	0.0205116
22-Jun-99	22.5	7.1	400	12000	20000	-10.8	16.11	202	0	9.66E-06	0.0095262
28-Jun-99	26	7.6	400	12000	20000	-9.1	19.563	322	0	1.07E-05	0.0105518
2-Jul-99	28	13.5	400	12000	20000	-8.3	4.603	212	0	6.55E-06	0.0064593
7-Jul-99	29	4.6	400	12000	20000	-8.3	6.9044	112	0	2.07E-05	0.0204133
14-Jul-99	27	10.8	400	12000	20000	-8.8	4.603	317	0	1.33E-05	0.0131158
18-Jul-99	27.5	9.4	400	12000	20000	-7.3	11.507	167	0	1.04E-05	0.0102589
26-Jul-99	27.5	10	400	12000	20000	-9.7	11.507	112	0	9.74E-06	0.0096041
28-Jul-99	28.5	3.4	400	12000	20000	-8	13.809	122	0	8.42E-06	0.0083034
31-Jul-99	31	12	400	12000	20000	-11.7	28.769	282	0	1.67E-05	0.0164687
1-Aug-99	31	8.6	400	12000	20000	-9.6	25.467	177	0	7.84E-06	0.0077314
3-Aug-99	28	7.4	400	12000	20000	-8.3	9.2059	167	0	2.79E-05	0.0275135
8-Aug-99	31	8.7	400	12000	20000	-8.1	13.809	277	0	7.83E-06	0.0077215
14-Aug-99	28	8	400	12000	20000	5.5	19.563	357	0	2.35E-05	0.0231745
20-Aug-99	20	7.5	400	12000	20000	-3.1	13.809	27	0	1.07E-05	0.0105518
24-Aug-99	29	7	400	12000	20000	-7.7	44.879	327	0	7.42E-06	0.0073172

Contd Table 1

date	Ground level conditions		aircraft condition			Jettison altitude			Results of jettison run		
	Mean Temp Celsius	Wind Speed mph	Speed mph	Fuel Jettison lbs	Altitude ft	Temp Celsius	wind speed mph	Direction degree	Ground fall %	max deposition ml/m2	mg/m2
1-Sep-99	28.5	10	400	12000	20000	-8.3	11.507	62	0	1.97E-05	0.0194271
3-Sep-99	28	9.1	400	12000	20000	-7.5	6.9044	307	0	1.90E-05	0.0187385
8-Sep-99	24	12.8	400	12000	20000	-9.5	33.371	292	0	1.19E-05	0.0117352
14-Sep-99	27.5	8.3	400	12000	20000	-13.5	24.166	242	0	6.32E-05	0.0623246
21-Sep-99	14.5	13.6	400	12000	20000	-12.8	44.879	287	0	3.79E-05	0.037375
25-Sep-99	19.5	7.5	400	12000	20000	-12.4	24.166	277	0	1.96E-05	0.0193285
27-Sep-99	22.5	11.9	400	12000	20000	-9.4	33.371	227	0	5.51E-06	0.0054337
5-Oct-99	16.5	4.5	400	12000	20000	-10.1	16.11	267	0	3.95E-05	0.0342487
10-Oct-99	22	2.8	400	12000	20000	-9.6	31.07	22	0	2.08E-05	0.0205118
17-Oct-99	13	19.3	400	12000	20000	-15.1	37.974	242	0	6.90E-05	0.0680442
25-Oct-99	18	11.2	400	12000	20000	-13.4	11.507	337	0	1.29E-05	0.0127213
29-Oct-99	20.5	18.9	400	12000	20000	-17.9	19.563	257	0	2.68E-05	0.0264426
31-Oct-99	13.5	12.3	400	12000	20000	-20.3	51.783	68	0	8.00E-05	0.0788918
2-Nov-99	9.5	17.8	400	12000	16000	-13.4	56.688	297	0	1.21E-04	0.1193239
5-Nov-99	18	16.3	400	12000	20000	-12.5	9.2059	237	0	1.01E-05	0.00997
10-Nov-99	18.5	10	400	12000	20000	-13.9	28.769	262	0	1.67E-05	0.0164687
14-Nov-99	19	8.1	400	12000	20000	-11.9	9.2059	227	0	2.92E-05	0.0287955
20-Nov-99	11	8.1	400	12000	20000	-15.2	24.166	342	0	1.31E-04	0.1288923
22-Nov-99	17.5	9.3	400	12000	20000	-17.8	58.686	217	0	2.83E-05	0.027908
24-Nov-99	5	7.4	400	12000	20000	-17.8	71.346	227	0	4.21E-05	0.0415168
26-Nov-99	10	11	400	12000	20000	-20.1	54.085	322	0	7.67E-05	0.0756376
28-Nov-99	10	8.8	400	12000	20000	-16.8	44.879	257	0	5.16E-05	0.0508852
2-Dec-99	16	21.2	400	12000	20000	-19.7	28.769	203	0	1.61E-05	0.0158868
4-Dec-99	12.5	11.6	400	12000	20000	-18.4	56.688	192	0	5.68E-05	0.0560132
10-Dec-99	5	9.1	400	12000	20000	-18.2	59.839	164	0	6.64E-05	0.0654802
14-Dec-99	6.5	16.6	400	12000	20000	-23.7	69.044	217	0	7.69E-05	0.0758348
20-Dec-99	0.5	12.9	400	12000	20000	-27.1	51.783	237	0.5	4.72E-04	0.4654619
30-Dec-99	9.5	13	400	12000	20000	-16.5	59.839	257	0	2.28E-05	0.0224642
31-Dec-99	6.5	6.1	400	12000	20000	-20.5	19.563	257	0	1.29E-04	0.1272131
1-Jan-00			400	12000	5000	9.8	16.11	237	3	0.0025214	2.4864738
10-Jan-00	0	10.1	400	12000	20000	-23.33	116.22	282	0	7.27E-05	0.071693
16-Jan-00	13.5	10.6	400	12000	20000	-15.3	35.673	267	0	1.40E-05	0.0138061
21-Jan-00	4.5	11.4	400	12000	20000	-20.1	69.044	277	0	8.16E-05	0.0809909
23-Jan-00	7.5	9.2	400	12000	20000	-21.9	66.745	262	0	9.50E-05	0.0936841
25-Jan-00	0.5	13	400	12000	20000	-19.2	71.346	222	0	8.08E-05	0.0796806
26-Jan-00	-1.5	8.3	400	12000	20000	-0.8	9.2059	322	0	6.07E-03	5.9722680
28-Jan-00	-4.5	7.6	400	12000	5000	-28.8	33.371	207	1	8.45E-04	0.8330655
1-Feb-00	0	8.7	400	12000	20000	-25.8	44.879	277	0	1.03E-04	0.1003266
6-Feb-00	7.5	13.9	400	12000	20000	-25.8	42.577	272	0	2.06E-04	0.2032451
17-Feb-00	10.5	9.7	400	12000	20000	-19.3	47.18	247	0	6.49E-05	0.064001
23-Feb-00	15.5	10.8	400	12000	20000	-27.9	44.879	237	0	5.29E-05	0.0521672
25-Feb-00	10.5	22.4	400	12000	20000	-19.6	64.085	217	0	1.51E-04	0.149007
27-Feb-00	12.5	7	400	12000	20000	-27.4	56.388	312	0	1.42E-04	0.140033
28-Feb-00	14.5	16	400	12000	20000	-27.4	47.18	287	0	1.79E-04	0.1765205
1-Mar-00	11.5	10.7	400	12000	20000	-16.7	44.879	277	0	1.01E-04	0.099601
3-Mar-00	6.5	13.8	400	12000	20000	-22.7	92.058	282	0	1.05E-04	0.1035456
6-Mar-00	13	12	400	12000	20000	-16.6	26.467	227	0	8.67E-05	0.085489
20-Mar-00	13.5	12.7	400	12000	20000	-19.8	42.677	257	0	7.50E-05	0.0739611
23-Mar-00	16	13.5	400	12000	20000	-17.3	73.647	187	0	2.65E-05	0.0261329
24-Mar-00	17	13.2	400	12000	20000	-14.5	54.085	247	0	2.40E-05	0.0236676
28-Mar-00	17.5	12.2	400	12000	20000	-19.1	59.839	312	0	3.94E-05	0.0388549
8-Apr-00	8	16.8	400	12000	20000	-18.1	89.758	302	0	7.22E-05	0.0711999
11-Apr-00	16	12.1	400	12000	20000	-18.7	24.166	262	0	2.98E-05	0.0294365
13-Apr-00	12	5.9	400	12000	20000	-19.2	31.07	252	0	2.68E-04	0.2638721
15-Apr-00	16.5	17.8	400	12000	20000	-16.2	19.563	252	0	1.03E-05	0.0101672
18-Apr-00	21	12.4	400	12000	20000	-41.1	31.07	277	0	2.15E-05	0.0212022
23-Apr-00	18.5	13.2	400	12000	5000	-21.2	73.647	227	0	8.03E-04	0.7918769
7-May-00	26	21.5	400	12000	20000	-12.8	16.11	262	0	4.33E-06	0.00427
12-May-00	24.5	16.2	400	12000	20000	-10.8	44.879	222	0	2.95E-06	0.0029091
21-May-00	22.5	8.2	400	12000	20000	-16.5	28.769	277	0	3.01E-05	0.0296831
22-May-00	20.5	10.9	400	12000	20000	-15.8	35.673	292	0	1.02E-05	0.0100587
28-May-00	23	7.1	400	12000	20000	-12.9	47.18	317	0	1.35E-05	0.013313
1-Jun-00	27	12	400	12000	20000	-9	16.11	167	0	8.02E-06	0.0079089
15-Jun-00	22.5	8.9	400	12000	20000	-6.1	28.769	312	0	2.06E-05	0.0203147
16-Jun-00	18.5	6.6	400	12000	20000	-9.9	31.07	287	0	2.10E-05	0.0207091
22-Jun-00	23.5	7.8	400	12000	20000	-9.7	24.166	207	0	5.90E-06	0.0058183
25-Jun-00	26	8.4	400	12000	20000	-11.2	6.9044	307	0	9.40E-06	0.0092698
1-Jul-00	28.5	11.2	400	12000	20000	-8	13.809	297	0	1.52E-06	0.0014989
7-Jul-00	27	8.4	400	12000	20000	-4.7	9.2059	77	0	2.13E-06	0.0021005
11-Jul-00	28.5	10.5	400	12000	20000	-6.4	13.809	227	0	2.85E-04	0.2810522
20-Jul-00	28.5	12	400	12000	20000	-8.2	16.11	267	0	9.07E-07	0.0008944
27-Jul-00	23.5	10.6	400	12000	20000	-11.3	33.371	21	0	1.04E-05	0.0102558
25-Jul-00	24.5	9.7	400	12000	20000	-5.2	47.18	342	0	1.31E-05	0.0129185
4-Aug-00	30	11	400	12000	20000	9.3	24.166	7	0	1.41E-05	0.0139047
8-Aug-00	30.5	12.3	400	12000	5000	23.3	33.371	217	0.2	2.55E-04	0.2514678
11-Aug-00	31	9.3	400	12000	20000	-8.4	4.603	347	0	1.50E-05	0.0147922
14-Aug-00	27.5	9.4	400	12000	20000	-6.7	24.166	227	0	1.20E-05	0.0118338
18-Aug-00	29	9	400	12000	20000	-7.3	16.11	257	0	9.70E-06	0.0095656
21-Aug-00	28.5	11.5	400	12000	20000	-6.2	16.11	312	0	8.08E-06	0.0079684
1-Sep-00	33	6.6	400	12000	20000	-6.2	16.11	207	0	7.50E-06	0.0073961
6-Sep-00	27	7.5	400	12000	20000	-6.5	13.809	7	0	6.01E-06	0.0059345
13-Sep-00	28	8.6	400	12000	20000	-6.5	13.809	357	0	2.90E-05	0.0285980
17-Sep-00	23	8.4	400	12000	20000	-9.1	19.563	352	0	1.12E-05	0.0110449
24-Sep-00	14.5	14.3	400	12000	20000	-7.1	44.879	247	0	1.05E-05	0.0103546
1-Oct-00	23.5	14.8	400	12000	20000	-7.1	28.769	277	0	1.47E-05	0.0144964
10-Oct-00	9	10.2	400	12000	20000	-17.5	18.412	267	0	2.08E-04	0.205316
11-Oct-00	16	12.6	400	12000	20000	-11.5	26.467	277	0	3.44E-05	0.0339205
13-Oct-00	22.5	13.2	400	12000	20000	-11.5	28.769	222	0	1.47E-05	0.0145361
16-Oct-00	19.5	7.6	400	12000	5000	13	16.11	142	0.5	1.09E-03	1.0746058
24-Oct-00	20.5	9.6	400	12000	20000	-12.6	19.563	162	0	1.71E-05	0.0168629
27-Oct-00	20.5	8.5	400	12000	20000	-14.4	18.412	222	0	2.11E-05	0.0208077
29-Oct-00	19.5	13.6	400	12000	20000	-13.3	47.18	187	0	1.06E-05	0.0103447
30-Oct-00	20	9.1	400	12000	20000	-12.8	35.673	357	0	6.61E-06	0.0065184
1-Nov-00	19.5	16.2	400	12000	20000	-12.8	69.044	202	0	3.00E-06	0.0029584
5-Nov-00	14	9.1	400	12000	20000	-17.4	26.467	247	0	6.60E-05	0.0648087
9-Nov-00	2.5	11.6	400	12000	20000	-19.7	59.639	277	0	2.71E-04	0.2672461
13-Nov-00	1	10	400	12000	20000	-29	125.43	232	0.01	8.23E-05	0.08116
16-Nov-00	4	14	400	12000	20000	-21.6	109.32	247	0.01	9.16E-05	0.0903312
21-Nov-00	5.5	8.9	400	12000	20000	-23.2	59.839	312	0.5	1.72E-04	0.1696176
23-Nov-00	10	7.7	400	12000	20000	-26.6	51.783	262	0.01	8.62E-05	0.085006
25-Nov-00	7	10.1	400	12000	20000	-21.8	18.412	312	0	1.23E-04	0.1212962
1-Dec-00	7	12.9	400	12000	20000	-17	69.044	262	0	2.61E-05	0.0257385
12-Dec-00	-10.5	11	400	11000	20000	-17.1	73.647	252	0.02	1.17E-04	0.1153793
17-Dec-00	-5	8.7	400	12000	5000	-8.9	56.388	322	5	8.16E-03	8.0356278
18-Dec-00	2.6	18.8	400	12000	20000	-16.2	82.14	267	0.1	6.38E-05	0.0629162
22-Dec-00	-2.5	11.5	400	12000	20000	-26.7	56.386	297	0.1	1.68E-04	0.1651
25-Dec-00	-5	8.7	400	12000	20000	22.9	64.085	242	0	1.52E-04	0.1499046
29-Dec-00	-1	9.7	400	12000	20000	-72.6	51.783	282	0	1.39E-04	0.1370746
1-Jan-01	5.5	11.4	400	12000	5000	-10.5	4.6	352	8	0.0065232	6.4328413
5-Jan-01	5.5	7.6	400	12000	20000	-15.6	64.08	317	0	5.46E-05	0.0538437
7-Jan-01	5	10.4	400	12000	20000	-23.1	33.3	267	0	1.91E-04	0.1884529
15-Jan-01	5.5	5.5	325	12000	20000	-35.3	27	347	0	1.41E-04	0.1390460
16-Jan-01	4	9	400	12000	20000	-25.8	49.482	322	0	1.10E-04	0.1084753
21-Jan-01	3	5.3	400	12000	5000	1	19.51	212	5	0.0045937	4.5300685
29-Jan-01	3.6	12	400	12000	20000	-20.6	92	172	0.5	7.80E-05	0.0769198
1-Feb-01	4.5	6.9	400	12000	20000	-24.4	82.8	267	0.4	1.69E-04	0.166659
2-Feb-01	0.5	9.5	400	12000	5000	-2.3	31	212	0	6.66E-03	6.5640976
4-Feb-01	8	12.5	400	12000	20000	-21.1	66.5	292	0	1.37E-04	0.1351023
7-Feb-01	11.5	10.7	400	12000	20000	-19.8	42.8	262	0	1.02E-04	0.1005871
10-Feb-01	-2.5	11	400	12000	5000	-7.6	35.9	327	8	7.21E-03	7.1101278
13-Feb-01	9.5	6.9	400	12000	20000	-19.6	54	232	0	6.63E-05	0.0653816
18-Feb-01	-0.5	15.5	400	12000	20000	-24.8	85.992	282	0	1.45E-04	0.1429915
1-Mar-01	1.5	6.4	400	12000	20000	-18.7	76.2	232	0.01	8.90E-05	0.0877672
8-Mar-01	9.5	8.7	400	12000	20000	-26.2	28.7	272	0	1.93E-04	0.1903264
11-Mar-01	13	11.9	400	12000	20000	-21.9	56.3	247	0.01	8.13E-05	0.0801738
16-Mar-01	5	18.7	400	12000	20000	-24.5	66.7	272	0.01	1.41E-04	0.1390469
27-Mar-01	4	7	400	12000	20000	-24.5	49.4	287	0.01	4.00E-04	0.3944592

Cont'd Table 1

date	Ground level condition: Mean Temp Celsius	Wind Speed mph	aircraft condition: Speed mph	Fuel Jettisoned lbs	Altitude ft	Jettison altitude: Temp Celsius	wind speed mph	Direction degree	Results of jettison run: Ground level %	max deposition mg/m2	mg/m2
1-Apr-01	11.5	10.3	400	12000	20000	-6.3	71.3	297	0	1.20E-04	0.1183378
6-Apr-01	22.5	11.5	400	12000	20000	-12.6	21.8	332	0	1.37E-05	0.0100117
7-Apr-01	21.5	14.3	400	12000	6000	28	43.25	226	0	1.05E-04	0.379867
11-Apr-01	18.5	15.9	400	12000	6000	-17.6	31.87	272	0	8.49E-04	0.8413053
13-Apr-01	17	8.6	400	12000	20000	-14.4	80.78	351	0	4.74E-05	0.0467434
14-Apr-01	15	10.4	400	12000	20000	-18.2	48.4	289	0	3.33E-06	0.0264786
16-Apr-01	11	8.5	400	12000	20000	-16.8	48.4	312	0	6.01E-05	0.0666026
1-May-01	21.5	17.7	400	12000	8000	-17.5	31.07	272	0	8.84E-04	0.7457283
2-May-01	21.4	13.2	400	12000	30000	-17.6	35.8	222	0	1.70E-05	0.0113304
7-May-01	15.6	4.6	400	12000	30000	-18	35.67	262	0	4.42E-05	0.0460785
11-May-01	21	10.1	400	12000	30000	-15.7	21.6	331	0	1.97E-05	0.0146029
13-May-01	21.5	7.5	400	12000	30000	-13.8	14.55	332	0	3.38E-05	0.0316006
24-May-01	13.5	10.1	400	12000	20000	-16.2	33.847	291	0	8.14E-06	0.0062838
1-Jun-01	15.5	10.1	400	12000	20000	-14.2	42.557	291	0	4.60E-05	0.0468628
7-Jun-01	23	8.4	325	12000	20000	-14.3	37	252	0	4.30E-06	0.0031172
17-Jun-01	28	10.9	400	12000	20000	-10.1	18.412	291	0	1.07E-05	0.0100541
20-Jun-01	25.5	7.5	400	12000	30000	-10.7	15.88	2	0	1.30E-05	0.0128184
21-Jun-01	24.5	8	400	12000	20000	-23.7	40.274	293	0	1.50E-05	0.0128189
1-Jul-01	26.1	7.9	350	14000	20000	-14.7	34	35	0	1.47E-05	0.0140003
2-Jul-01	25.8	8	325	14000	20000	-9.7	34	32	0	3.48E-06	0.0031171
14-Jul-01	25	0.3	350	12000	20000	-3.7	20	347	0	7.70E-05	0.0316053
23-Jul-01	31.5	13.3	350	12000	20000	-6.3	4	181	0	1.20E-05	0.0121290
1-Aug-01	30	2.3	300	12000	20000	-3.5	11.607	242	0	6.03E-06	0.0064755
8-Aug-01	30	8.3	350	12500	20000	-4	21	32	0	1.33E-05	0.0131168
11-Aug-01	27	5.9	400	12000	20000	-8.7	6.9044	135	0	2.27E-05	0.0223850
15-Aug-01	28	15.9	345	14000	20000	-6.0	16	281	0	1.11E-05	0.0106463
29-Aug-01	24.5	7.4	350	12000	20000	-8.8	11	152	0	1.48E-05	0.014585
31-Aug-01	24.8	6.6	350	12000	20000	-8.3	11	287	0	2.54E-05	0.0230750
5-Sep-01	24	5.0	400	12000	6000	12	10.683	0	0	2.40E-05	0.0202315
8-Sep-01	10.5	15	400	12000	6000	17	10.585	0	0.5	1.25E-03	1.2306207
4-Oct-01	27	12.7	400	12000	6000	14.4	33.316	187	0.5	8.02E-04	0.8050017
7-Oct-01	13	12.7	400	12000	8000	8.2	10.357	277	2	2.31E-03	2.2514530
8-Oct-01	16.8	16.9	400	12000	20000	-15.6	20.948	265	0	1.96E-05	0.0183286
16-Oct-01	13.5	5.4	400	12000	6000	11.7	8.6044	182	0.5	2.27E-03	2.2362003
25-Oct-01	12	0.6	400	12000	20000	-12.4	67.413	373	0	1.48E-05	0.014584
27-Oct-01	11.6	7.4	400	12000	30000	-16.2	26.467	337	0	1.72E-04	0.1700034
1-Nov-01	20.5	18.1	400	12000	30000	-11.7	40.376	293	0	8.38E-06	0.0082325
8-Nov-01	8	8.9	400	12000	20000	-30.0	30.713	242	0	2.35E-04	0.2317446
10-Nov-01	12.5	4.3	400	12000	20000	-18.0	16.612	277	0	1.22E-04	0.1200101
16-Nov-01	18	5.2	400	12000	20000	-13.4	18.11	157	0	1.08E-04	0.1074801
23-Nov-01	15	18.8	400	12000	30000	-14.7	25.314	242	0	3.40E-05	0.0344198
27-Nov-01	-1.5	18.4	400	12000	17000	-5.7	67.813	227	0	1.52E-04	0.150750
30-Nov-01	8	13	400	12000	22000	-0.9	51.236	347	1	6.27E-04	0.6183149
3-Dec-01	16	15.5	350	12000	20000	-10.7	20	312	0	1.45E-05	0.0142901
5-Dec-01	8	8.1	350	12000	20000	18.3	85	204	0	8.54E-06	0.0084406
9-Dec-01	8	18	350	12000	20000	-13.1	50	210	0	1.40E-05	0.0136061
12-Dec-01	4.3	5.8	400	12000	18000	-8	60.586	187	0	4.82E-06	0.0059760
14-Dec-01	8	9.1	400	12000	18000	-9.2	88.644	207	0	7.04E-05	0.0804266
22-Dec-01	8	18	400	12000	20000	-21.7	104.77	227	0	4.13E-05	0.0400283
31-Dec-01	N/A	N/A	400	12000	18000	-22.4	65.307	257	0.6	3.40E-04	0.3308106
1-Jan-02	1.6	5.5	400	12000	20000	-24.8	42.14	253	0.5	5.25E-04	0.5177274
5-Jan-02	-5	6.5	400	12000	6000	-0.2	28.713	333	8	6.0651207	5.0622280
6-Jan-02	0.5	5.5	400	12000	20000	-18.8	43.728	352	0	5.67E-05	0.0574880
12-Jan-02	7	11.5	345	12000	20000	-18.3	43.7386	303	0	1.31E-04	0.1281854
13-Jan-02	7	11.6	345	12000	20000	-18.3	37.0731	301	0	1.02E-05	0.0100883
14-Jan-02	8.5	21.6	345	14000	20000	-29.6	94.0586	287	1	2.95E-04	0.2880127
15-Jan-02	9	0.8	335	12000	20000	-34.3	31.0680	347	0	4.30E-05	0.0474641
16-Jan-02	4.5	8.4	345	14000	20000	-20.2	101.28	252	0.3	1.43E-04	0.1410487
21-Jan-02	4	6.6	400	12000	20000	-14.5	72.491	212	0	4.06E-05	0.0402335
23-Jan-02	11.6	12.6	400	12000	20000	-15.8	72.858	212	1	5.44E-05	0.0536485
30-Jan-02	0.4	15.5	400	12000	20000	-15.4	71.346	227	0	1.85E-05	0.0485461
1-Feb-02	8	8.3	200	12000	20000	-20.5	118.46	212	2	6.44E-04	0.6350794
4-Feb-02	3.5	7.6	350	12000	20000	-16.8	46.3	87	0.7	2.22E-04	0.2188248
8-Feb-02	5.5	19.4	400	12000	20000	-21.7	82.863	252	0	8.37E-05	0.0835404
14-Feb-02	4	13.2	350	15000	20000	-24.6	44.7284	322	5	1.58E-04	0.1577637
16-Feb-02	4	5.8	300	14000	20000	-34.6	68.5802	282	0.1	2.96E-05	0.0290477
18-Feb-02	8	5.9	325	14000	20000	-16.8	60.713	272	0	4.09E-05	0.0406005
23-Feb-02	12.5	13.7	400	12000	20000	-13.9	32.034	333	0	9.81E-05	0.0647195
27-Feb-02	-3	6.8	400	12000	20000	-28.2	79.405	287	0.5	1.61E-04	0.1644097
3-Mar-02	-7.5	16.9	345	12000	20000	-21.2	58.4481	252	0.1	2.10E-05	0.0207481
8-Mar-02	1.5	17.6	400	12000	18000	-11.7	82.099	267	0.1	1.34E-04	0.1341161
13-Mar-02	17	17.6	300	14000	20000	15.7	41.6513	282	0	6.21E-06	0.006163
15-Mar-02	0.3	10.5	400	12000	20000	-17.7	84.004	242	0	6.12E-09	0.0013304
18-Mar-02	11.1	8.2	350	12000	20000	-18	44.8773	282	0.1	7.80E-05	0.0780932
22-Mar-02	6	15.4	350	12000	20000	-20.5	31.6717	272	0.1	1.19E-05	0.0117353
23-Mar-02	6	15.4	400	12500	20000	-20.7	35.764	282	0	1.27E-04	0.1287406
27-Mar-02	10.5	17	400	12000	18000	-10.3	39.435	272	0	9.00E-06	0.0087531
31-Mar-02	14	7.6	350	12000	20000	-17.6	23.014	312	0.3	2.10E-04	0.2070011
2-Apr-02	11	21.1	350	12000	20000	-16	17.28	66	0	5.33E-04	0.5250100
3-Apr-02	6.5	14.8	350	12000	20000	-18	43.73	272	0.1	2.15E-04	0.2120210
4-Apr-02	8	6.7	350	12000	20000	-20.4	30.37	272	0	1.10E-04	0.1084761
8-Apr-02	15	7.1	345	14000	20000	-26.6	35.37	312	0.1	1.65E-04	0.1640007
10-Apr-02	10	11.6	350	12000	20000	-18.9	33.01	307	0	6.33E-04	0.6250100
14-Apr-02	21.5	6.6	350	12000	20000	-31.7	33.37	307	0	5.33E-04	0.5250100
17-Apr-02	24.5	15.7	350	12000	20000	-28	33.37	232	0	5.33E-04	0.5250100
3-May-02	25.5	10.5	400	12000	20000	-13.4	37.532	252	0	6.20E-06	0.006103
9-May-02	18.5	8.7	350	12000	20000	-14	88.16	253	0	2.23E-05	0.0210011
11-May-02	27.5	15.5	400	12000	20000	17.7	37.874	227	0	4.14E-05	0.0040827
16-May-02	19	12.1	400	12000	20000	17.1	38.873	247	0	3.50E-05	0.0314581
24-May-02	18.6	10.8	350	12000	20000	13.7	40.77	260	0	2.23E-05	0.0210011
4-Jun-02	24.8	15.7	345	12000	20000	8.5	38.74	242	0	2.00E-05	0.0278497
11-Jun-02	26	19.4	345	12000	20000	10.7	10.33	322	0	9.37E-05	0.0092402
19-Jun-02	23	14.9	350	12000	20000	-10.5	44.40	247	0	1.94E-05	0.0191313
24-Jun-02	23.5	9.1	345	12000	20000	-8.0	17.28	13	0	1.66E-05	0.0163761
28-Jun-02	27	3.5	350	12000	20000	-8.8	14.95	62	0	1.01E-05	0.0108334
29-Jun-02	31.5	12.4	345	12000	20000	0.2	18.35	63	0	8.71E-06	0.0065800
1-Jul-02	22	8.5	400	12000	20000	-8.1	2.3679	317	0	1.40E-05	0.0140050
3-Jul-02	26	7.6	400	12000	20000	-9.6	17.281	167	0	1.03E-06	0.0008040
18-Jul-02	28	8.7	400	17000	20000	10.1	30.367	217	0	3.03E-05	0.0234403
24-Jul-02	28	5.8	400	12000	20000	-11.2	30.412	272	0	1.75E-05	0.0177805
26-Jul-02	28	12.7	400	12000	20000	7.4	14.08	212	0	7.14E-06	0.0070411
31-Jul-02	27.5	10.4	400	12000	20000	-4	4.0044	107	0	8.74E-06	0.0080243
1-Aug-02	30	9.3	350	12000	20000	3.5	14.201	42	0	8.16E-05	0.0810076
6-Aug-02	28	8	400	12000	20000	5.7	8.2048	137	0	3.10E-05	0.0311
11-Aug-02	27.5	15.4	400	17000	10000		37.17		0	8.64E-06	0.0087453
14-Aug-02	22	8.4	400	17000	20000	-10.7	23.768	317	0	2.43E-05	0.0241609
18-Aug-02	24.5	12.0	400	17000	10000	-10	5.7531	2	0	8.84E-06	0.0087453
20-Aug-02	30	9.3	400	12000	20000	9.5	11.501	272	0	8.80E-06	0.0087327
3-Sep-02	28.5	10.6	400	12000	20000	7	9.7137	322	0	8.27E-06	0.0081446
7-Sep-02	28.5	7.1	400	12000	20000	-8.4	8.7088	87	0	1.07E-05	0.010177
15-Sep-02	21.5	10.3	400	12000	20000	-4.3	10.357	312	0	1.68E-04	0.1620047
18-Sep-02	28	14.7	400	12000	20000	8	20.373	237	0	6.04E-06	0.0060477
23-Sep-02	28	2.5	400	12000	20000	-14.5	8.0544	312	0	1.21E-05	0.0117452
28-Sep-02	25	6.8	400	12000	20000	-10.1	30.715	272	0	1.62E-05	0.0160
1-Oct-02	24.5	10.8	400	12000	20000	-12.7	27.415	237	0	6.12E-06	0.006
8-Oct-02	24	8.5	400	12000	20000	-8.7	38.424	212	0	7.81E-06	0.0075040
17-Oct-02	12	4.8	400	12000	20000	-10.0	64.441	257	0	8.40E-05	0.083734
19-Oct-02	12.3	8.8	400	12000	20000	14.4	17.241	307	0	2.65E-04	0.2613282
22-Oct-02	19	5.8	400	12000	20000	-10.1	33.371	272	0	1.29E-04	0.1271117
23-Oct-02	10.5	7.4	400	13000	20000	-18.7	49.442	272	0	6.71E-05	0.0665438
1-Nov-02	4	9.8	400	12000	20000	-16.67	55.236	297	0.5	1.47E-04	0.1405671
5-Nov-02	5.5	4.3	400	12000	20000	-12.6	66.866	252	0	4.30E-05	0.0420090
7-Nov-02	12.5	11.6	400	13000	20000	-18.1	48.467	302	0	5.60E-05	0.0511846
16-Nov-02	7.5	4.1	400	13000	20000	-27.7	23.015	297	0	1.57E-04	0.1550275
18-Nov-02	12.5	12	400	12000	20000	-17.5	37.337	299	0	2.07E-05	0.0202646
20-Nov-02	12	7.5	400	12000	20000	-22.5	54.066	243	0	8.28E-05	0.0827376
23-Nov-02	1	14.1	400	12000	20000	-22.5	50.858	242	0	1.00E-04	0.0986446
5-Dec-02	3.5	8	400	12000	20000	-24.6	36.836	277	0	4.15E-04	0.4122089
11-Dec-02	5.5	10.8	400	12000	20000	-22.1	16.412	327	0	2.40E-04	0.2454605
13-Dec-02	8.5	8.8	400	12000	20000	-17.1	44.876	352	0	7.31E-05	0.0720973
18-Dec-02	11	7.5	400	12000	20000	-22.8	82.098	322	0	5.44E-05	0.0536437
20-Dec-02	5	8.7	400	13000	20000	-26.3	35.314	287	0	2.67E-04	0.2583706
24-Dec-02	5	14.8	400	13000	20000	-24.3	77.487	303	0	1.32E-04	0.1301116
28-Dec-02	3	6.6	400	12000	20000	-24.2	84.804	262	0	1.45E-04	0.1432473
31-Dec-02	-4	4.8	400	12000	20000	-22.4	85.387	257	0.1	2.41E-04	0.2375434

Table 2:
Summary of Runs for KC-135

date	Ground level condition		aircraft condition			Jettison altitude			Results of jettison run		
	Mean Temp Celsius	Wind Speed mph	Speed mph	Fuel Jettis lbs	Altitude ft	Temp Celsius	wind speed mph	Direction degrees	Ground fa %	max deposition m/m2	mg/m2
1-Jan-96	4.4	16.8	400	12000	20000	-38.1	65.592	227	0.1	1.47E-04	0.144983771
2-Jan-96	-0.1	21.3	400	12000	20000	-26.9	31.07	182	0.1	3.21E-04	0.31655354
5-Jan-96	-4.8	18	400	12000	20000	-31.7	84.004	247	0.1	2.42E-04	0.2286
10-Jan-96	7.7	9.8	400	12000	20000	-41.8	44.679	262	0.1	3.39E-04	0.334304206
14-Jan-96	10.2	9.2	400	12000	20000	-16.0	43.728	272	0	1.21E-05	0.011902808
17-Jan-96	13.9	16	400	12000	20000	-22.4	34.522	242	0	4.00E-05	0.04028415
21-Jan-96	4.1	10.7	400	12000	20000	-33	57.537	287	0	2.31E-04	0.227800211
24-Jan-96	2.7	0.7	400	12000	20000	-35.8	117.38	262	0	1.63E-05	0.016074214
27-Jan-96	-0.6	9.3	400	12000	20000	16.1	44.670	302	0	9.40E-05	0.092867921
28-Jan-96	6.4	22.2	400	12000	20000	-19.4	90.909	252	0	6.78E-05	0.066860941
30-Jan-96	-5.3	16.2	400	12000	20000	-18.6	52.934	256	0	1.12E-04	0.110448687
31-Jan-96	-10.3	13.5	400	12000	20000	-20.4	83.291	277	0	2.33E-04	0.229772507
1-Feb-96	-10	10.1	400	12000	20000	22.4	60.552	252	0	1.98E-04	[illegible]
3-Feb-96	-14.5	13.3	400	20000	20000	-28.9	57.537	282	2	5.11E-04	0.503921670
8-Feb-96	14.4	9.4	400	20000	20000	-19.9	43.291	282	0.1	1.10E-04	0.104180447
11-Feb-96	8.9	16.5	400	12000	20000	-19.7	63.291	277	0.1	1.32E-04	0.130171549
14-Feb-96	15.8	6.9	400	12000	20000	-17.4	41.427	282	0	7.26E-05	0.071594352
17-Feb-96	7.7	13.3	400	12000	20000	-19.3	68.743	312	0	1.00E-04	0.187460754
20-Feb-96	16.1	10.7	400	12000	20000	-29.3	65.743	312	0	1.43E-05	0.014101918
22-Feb-96	21.5	10	400	12000	20000	-15.8	55.236	262	0	[illegible]E-06	0.006863591
26-Feb-96	20.5	17.2	400	12000	20000	-18.1	00.909	207	0	1.44E-05	0.014200533
28-Feb-96	-0.9	20.4	400	12000	20000	-23.7	101.27	237	1	2.34E-04	0.230758855
1-Mar-96	3	8.5	400	12000	20000	-32.4	50.839	252	0.5	2.50E-04	0.246537025
4-Mar-96	14.4	17.1	400	12000	20000	-23.1	48.03	272	0	1.00E-04	0.09881481
7-Mar-96	-5.9	24.1	400	12000	20000	-31.6	39.125	382	1.5	2.70E-04	0.274149172
8-Mar-96	-2.3	5.5	400	12000	20000	-31.0	57.537	312	1	6.93E-04	0.683400633
14-Mar-96	20.7	15.5	400	12000	20000	22.4	28.919	207	0	3.41E-04	0.336276502
18-Mar-96	10.5	18.2	400	12000	20000	-26.1	18.563	207	0.5	2.45E-04	0.241806285
22-Mar-96	12.7	0.7	400	12000	20000	-22.6	42.577	302	0	1.84E-04	0.181728238
27-Mar-96	2.2	8.8	400	12000	20000	-20.8	58.339	242	0	1.42E-04	0.14023028
29-Mar-96	11.4	12.7	400	12000	20000	-20.7	34.522	207	0	9.10E-05	0.089738477
31-Mar-96	8	18.9	400	12000	20000	-21.8	48.03	277	0	8.80E-05	0.087767181
1-Apr-96	11.1	7.6	400	12000	20000	-21.5	48.03	322	0	1.02E-04	0.100685721
3-Apr-96	17.7	19.0	400	12000	20000	-17.8	13.309	232	0	5.73E-05	0.056506286
6-Apr-96	8	8.9	400	12000	20000	-23.7	14.96	262	0	1.86E-04	0.183285028
9-Apr-96	18.3	7.5	400	12000	20000	-16.6	44.679	322	0	9.61E-06	0.009478883
11-Apr-96	21.8	20.7	400	12000	20000	-17.4	28.769	277	0	5.32E-06	0.005246308
15-Apr-96	10.5	21.2	400	12000	18000	0.3	55.236	342	5	1.19E-04	0.117748063
20-Apr-96	16.9	10	400	12000	20000	-19.3	70.195	252	0	8.31E-05	0.081948907
24-Apr-96	19.2	18.3	400	12000	20000	-18.3	56.386	307	0	7.60E-05	0.075538944
27-Apr-96	18	16.4	400	12000	20000	-15	58.886	212	0	4.19E-05	0.041723649
30-Apr-96	13.3	11.3	400	12000	20000	-18.5	65.155	202	0	8.51E-05	0.083921203
1-May-96	17.2	8.6	400	12000	20000	-19	60.089	272	0	8.34E-05	0.082244752
3-May-96	23	12.7	400	12000	20000	-14.8	41.427	262	0	1.34E-05	0.013165077
6-May-96	23.8	8.1	400	12000	20000	-12.8	6.0553	354	0	5.91E-04	0.582815527
8-May-96	23.8	19.5	400	12000	20000	-23.1	14.96	117	0	1.22E-05	0.012031007
11-May-96	14.1	13.1	400	12000	20000	-23.1	41.427	287	0	1.16E-05	0.011340700
15-May-96	25.5	18.3	400	12000	20000	-14.4	13.809	232	0	8.52E-06	0.008401932
20-May-96	26.6	16.6	400	12000	20000	-7.4	28.769	267	0	5.07E-06	0.005000757
24-May-96	26.9	15.8	400	12000	20000	-12.2	40.276	172	0	5.44E-06	0.005364646
29-May-96	18.1	8.7	400	12000	20000	-12.2	50.633	272	0	1.57E-05	0.015452941
31-May-96	23.3	10.2	400	12000	20000	-13.7	10.357	147	0	1.79E-05	0.017652051
2-Jun-96	22.2	4.8	400	12000	20000	-14.6	33.371	292	0	7.10E-05	0.070016516
5-Jun-96	24.1	11.3	400	12000	20000	-14.1	33.371	307	0	6.54E-06	0.006421706
8-Jun-96	18.5	13.2	400	12000	20000	-18.4	66.807	307	0	2.80E-05	0.027189984
11-Jun-96	23.8	7.3	400	12000	20000	-10.4	23.016	317	0	3.48E-05	0.034320724
14-Jun-96	26.7	7.3	400	12000	20000	-7.6	8.0044	102	0	4.76E-05	0.047137079
18-Jun-96	29.4	9	400	12000	20000	-18.1	10.357	207	0	3.17E-05	0.031260695
22-Jun-96	28.2	8.9	400	12000	20000	-7.4	18.11	232	0	2.08E-05	0.020527384
27-Jun-96	28.3	10.4	400	12000	20000	-3.8	13.809	162	0	1.03E-05	0.010107187
29-Jun-96	29.7	9.2	400	12000	18000	-4.7	24.166	112	0	3.25E-05	0.032049813
1-Aug-96	24.5	8.6	400	12000	20000	-8	10.11	287	0	1.41E-05	0.013900168
3-Aug-96	24.8	11.3	400	12000	20000	-8.5	40.482	302	0	7.86E-06	0.007673017
5-Aug-96	30	15.6	400	12000	20000	-4.9	10.543	172	0	5.41E-06	0.005335061
6-Aug-96	28	13.2	400	12000	20000	-7.2	14.96	157	0	7.13E-06	0.007031236
8-Aug-96	27	9.1	400	12000	20000	-8.3	8.0552	192	0	3.35E-05	0.033048813
10-Aug-96	24.3	7.7	400	12000	20000	-8.1	42.677	282	0	2.01E-05	0.019801438
12-Aug-96	22	7.9	400	12000	20000	-8.1	42.577	2	0	1.25E-05	0.01232[illegible]51
15-Aug-96	25.5	7.1	400	12000	20000	-9.6	37.221	357	0	3.27E-06	0.003247043
17-Aug-96	25.5	5.8	400	12000	20000	-7.2	14.96	167	0	9.03E-06	0.008804008
18-Aug-96	27	8.9	400	12000	20000	-9.2	14.96	307	0	1.75E-05	0.017257592
1-Sep-96	24.5	5.6	400	12000	20000	-11.8	[illegible]	328	0	8.74E-05	0.086189344
3-Sep-96	23.5	7.6	400	12000	20000	-11.2	6.7537	7	0	1.05E-05	0.010220006
6-Sep-96	28.5	8	400	12000	20000	-9	19.583	07	0	2.45E-05	0.024160026
7-Sep-96	25	9.1	400	12000	20000	-7.8	18.11	237	0	1.47E-05	0.014406377
10-Sep-96	27	4.5	400	12000	20000	-11.3	21.064	12	0	2.45E-05	0.024160026
12-Sep-96	23.5	6	400	12000	20000	-10.3	24.106	257	0	3.58E-06	0.005407757
16-Sep-96	19	11.7	400	12000	20000	-8	35.873	292	0	1.27E-05	0.012524081
21-Sep-96	10.5	6.1	400	12000	20000	-10.8	62.14	307	0	3.43E-05	0.03382484
26-Sep-96	16	17	400	12000	20000	-9.7	51.703	222	0	1.12E-05	0.011044859
29-Sep-96	17.5	7.8	400	12000	20000	-10.6	26.487	307	0	2.69E-05	0.020527384
1-Oct-96	18.5	12	400	12000	20000	-9.5	10.157	307	0	2.43E-05	0.023963309
5-Oct-96	17.5	7.1	400	12000	20000	-13.4	9.2659	182	0	3.67E-05	0.036191535
8-Oct-96	16	11.2	400	12000	20000	-13.5	58.666	337	0	8.27E-05	0.081338412
11-Oct-96	16.5	11.4	400	12000	20000	-11.8	12.658	312	0	2.13E-05	0.021004965
14-Oct-96	19	13.6	400	12000	20000	-14.3	31.522	212	0	8.18E-06	0.00905784
18-Oct-96	11	8.3	400	12000	20000	-14.7	71.346	202	0	8.41E-05	0.082935065
21-Oct-96	14.5	12.5	400	12000	20000	-16.8	47.18	217	0	4.87E-05	0.048025412
24-Oct-96	14.5	12	400	12000	20000	-19.9	48.03	222	0	7.10E-05	0.070004048
28-Oct-96	10.5	8.4	400	12000	20000	-10.3	41.427	247	0	3.62E-05	0.035698561
30-Oct-96	13	6.1	400	12000	20000	-15.6	58.689	282	0	4.83E-05	0.047630953
4-Nov-96	11	16	400	12000	20000	-15.2	73.647	212	0	4.60E-05	0.045362813
11-Nov-96	8	9	400	12000	20000	-16.8	57.537	312	0	6.60E-05	0.065085775
13-Nov-96	8	6.8	400	12000	20000	-15	31.07	282	0	6.74E-05	0.066466382
15-Nov-96	14.6	14.6	400	12000	20000	-19	51.783	202	0.1	5.57E-05	0.054927449
17-Nov-96	6	12.4	400	12000	6000	2.8	36.873	317	4	2.64E-03	2.600768084
20-Nov-96	15	8.4	400	12000	20000	-11.6	48.482	280	0	2.01E-05	0.019811715
23-Nov-96	14	15.6	400	12000	20000	-15	43.728	222	0	1.46E-05	0.014397762
26-Nov-96	-0.5	20.9	400	12000	20000	-21.4	78.769	327	0.1	1.31E-04	0.129066766
27-Nov-96	0.6	6.4	400	12000	20000	-21.3	58.366	237	0.1	1.65E-04	0.162714437
30-Nov-96	5.5	9.6	400	12000	20000	-23.7	84.004	217	0	8.48E-05	0.083625369

Cont'd Table 2

date	Ground level conditi		aircraft condition			jettison altitude			Results of jettison run		
	Mean Tem Celsius	Wind Spe mph	Speed mph	Fuel Jettis lbs	Altitude ft	Temp Celsius	wind spee mph	Direction degree	Ground fa %	max deposition ml/m2	mg/m2
1-Jan-97	15	9.7	402.76	12000	20000	-13.5	33.371	0	0.1	5.05E-05	0.049830063
5-Jan-97	7.5	13.2	402.76	12000	20000	-19.4	96.562	270	0.1	1.05E-04	0.103644165
8-Jan-97	0	7.3	402.76	12000	20000	-25.5	94.381	217	0.2	1.64E-04	0.161728288
15-Jan-97	0.5	19.8	402.76	12000	20000	-27.9	118.53	212	0.2	1.17E-04	0.115379328
16-Jan-97	-2.5	15.7	402.76	12000	20000	-24.1	56.386	257	0.1	1.86E-04	0.183423547
21-Jan-97	15.5	21.3	402.76	12000	20000	-18	31.07	207	0.1	3.97E-05	0.03915008
23-Jan-97	11	9.3	402.76	12000	20000	-19.4	64.441	232	0	8.81E-05	0.086879045
27-Jan-97	1.5	17.1	402.76	12000	20000	-21.1	59.839	242	0	6.40E-05	0.063113478
29-Jan-97	0	9.7	402.76	12000	20000	-22.7	9.2059	257	0.1	3.19E-04	0.314581244
1-Feb-97	12.5	5.3	402.76	12000	20000	-14.8	28.769	367	0	8.10E-05	0.079877996
4-Feb-97	10	16	402.76	12000	20000	-19.6	75.949	257	0	7.98E-05	0.078694648
8-Feb-97	-1.5	13.6	402.76	12000	20000	-23.1	82.853	272	0.5	4.00E-04	0.39445924
10-Feb-97	2.5	6.9	402.76	12000	20000	-26.2	35.673	297	0.4	3.79E-04	0.37375013
15-Feb-97	7	10.4	402.76	12000	20000	-27.4	56.386	302	0.1	2.20E-04	0.216952582
18-Feb-97	13.5	20.6	402.76	12000	20000	-17.1	40.276	237	0	1.59E-05	0.015679755
23-Feb-97	8	7.9	402.76	12000	20000	-25.6	71.346	257	0.1	2.11E-04	0.208077249
26-Feb-97	5	8.4	402.76	12000	20000	-18.2	87.456	232	0	7.37E-05	0.072679115
28-Feb-97	10	12.4	402.76	12000	20000	-18.9	64.441	227	0	6.67E-05	0.065776078
1-Mar-97	11	12.4	402.76	12000	20000	-29.4	75.949	217	0	5.58E-05	0.054629834
3-Mar-97	10.5	10.8	402.76	12000	20000	-15.8	58.388	247	0	6.11E-05	0.060253649
8-Mar-97	8.5	18.3	402.76	12000	20000	-23.3	62.14	267	0	1.32E-04	0.129698198
10-Mar-97	12	7.3	402.76	12000	20000	18.2	40.276	262	0	1.09E-04	0.107588758
12-Mar-97	16.5	10.2	402.76	12000	20000	-18.3	19.563	102	0	5.89E-05	0.058084123
20-Mar-97	15	6.7	402.76	12000	20000	-16.4	44.879	22	0	4.94E-05	0.048715716
21-Mar-97	21.5	12.9	402.76	12000	20000	-13.7	21.864	307	0	2.08E-05	0.020551326
26-Mar-97	11	6	402.76	12000	20000	-21.5	51.783	37	0	1.51E-04	0.148711133
28-Mar-97	16	19.9	402.76	12000	20000	-20.2	66.743	252	0	5.28E-05	0.05206962
31-Mar-97	11.5	9.8	402.76	12000	20000	-20.7	21.864	252	0	1.72E-04	0.169617473
3-Apr-97	16.5	9.6	402.76	12000	20000	19.4	21.864	202	0	8.76E-05	0.086386574
5-Apr-97	16	16.1	402.76	12000	20000	-19.1	102.42	162	0	4.88E-05	0.048124027
8-Apr-97	9.5	13	402.76	12000	20000	-22.1	47.16	227	0	8.00E-05	0.078891848
12-Apr-97	0.5	10.9	402.76	12000	20000	-20.1	49.482	247	0	2.41E-04	0.237661692
16-Apr-97	15	11	402.76	12000	20000	-21.6	19.563	262	0	1.79E-04	0.17652051
22-Apr-97	16.5	13.3	402.76	12000	20000	-17.6	51.783	272	0	9.02E-05	0.088950559
24-Apr-97	12	6.9	402.76	12000	20000	-20.5	26.467	282	0	1.63E-04	0.16074214
26-Apr-97	10.5	11.9	402.76	12000	20000	-17	31.07	237	0	1.30E-04	0.128199253
3-May-97	13	13.5	402.76	12000	20000	-20.1	85.155	277	0	8.40E-05	0.08283644
5-May-97	20	13.3	402.76	12000	20000	16.2	33.371	267	0	8.40E-05	0.08283644
15-May-97	20	7	402.76	12000	20000	-17.3	42.577	297	0	8.48E-06	0.008362536
23-May-97	20	9.7	402.76	12000	20000	-9.9	26.467	322	0	5.92E-05	0.058379968
5-Jun-97	20	6.6	402.76	12000	20000	-10.6	33.371	342	0	1.98E-05	0.019486286
8-Jun-97	22.5	7	402.76	12000	20000	-12.2	9.2059	242	0	3.36E-05	0.033134576
22-Jun-97	25	15	402.76	12000	20000	-20.4	21.864	97	0	9.81E-06	0.009674113
1-Jul-97	28.5	17	402.76	12000	20000	-5	26.467	310	0	3.62E-06	0.003569856
7-Jul-97	23.5	9.4	402.76	12000	20000	10.7	18.412	312	0	3.46E-05	0.034317954
14-Jul-97	30.5	10.1	402.76	12000	20000	-9.5	9.2059	352	0	1.77E-05	0.017405514
25-Jul-97	29	10.5	402.76	12000	20000	-7	13.809	137	0	1.09E-05	0.01071943
31-Jul-97	24.5	8.2	402.76	12000	20000	-5.5	11.507	37	0	2.30E-05	0.022681406
2-Aug-97	26.5	8.2	402.76	12000	20000	-5.4	6.9044	17	0	1.51E-05	0.014841529
2-Aug-97			402.76	12000	20000	-5.4	6.9044	17	0	1.59E-05	0.015679755
11-Aug-97	25	7.7	402.76	12000	20000	-6.4	26.467	227	0	8.43E-06	0.008313228
17-Aug-97	27.5	13.6	402.76	12000	20000	-10	26.467	257	0	5.74E-06	0.00566049
24-Aug-97	24	8.4	402.76	12000	20000	-9.9	11.507	342	0	3.02E-05	0.029732365
31-Aug-97	28	7.9	402.76	12000	20000	-10.1	13.809	312	0	1.51E-05	0.014890836
1-Sep-97	26	7.1	402.76	12000	20000	-7.1	13.809	357	0	1.37E-05	0.013510229
4-Sep-97	22	6.1	402.76	12000	20000	-6.6	4.603	62	0	3.43E-05	0.03382486
9-Sep-97	26	9.9	402.76	12000	20000	-11.4	42.577	317	0	1.38E-05	0.013579259
17-Sep-97	29	11.6	402.76	12000	20000	-7.6	28.769	247	0	6.96E-06	0.006863591
19-Sep-97	28	18.9	402.76	12000	20000	-6.8	18.11	252	0	6.35E-06	0.00626204
23-Sep-97	20.5	6.9	402.76	12000	20000	-8.2	42.577	207	0	1.05E-05	0.010364417
26-Sep-97	19.5	4.7	402.76	12000	20000	-7.0	4.603	47	0	2.17E-05	0.021399414
2-Oct-97	26	13.9	402.76	12000	20000	-11.4	6.9044	137	0	2.02E-05	0.019870884
5-Oct-97	23	13.1	402.76	12000	20000	-8.6	11.507	147	0	1.74E-05	0.017158077
10-Oct-97	23.5	8.3	402.76	12000	20000	-8.6	16.11	182	0	3.09E-05	0.030422669
13-Oct-97	12.5	13.9	402.76	12000	6000	4.5	40.276	327	1	9.85E-01	971.4840776
17-Oct-97	14	7.7	402.76	12000	20000	20.5	21.864	352	0	1.37E-04	0.13510229
24-Oct-97	14	6.7	402.76	12000	20000	-20	54.085	242	0	8.77E-05	0.086762226
30-Oct-97	18	14	402.76	12000	20000	-17.6	28.769	252	0	4.25E-05	0.041911294
2-Nov-97	13	13.9	402.76	12000	20000	-29.4	87.456	297	0	1.52E-04	0.149707143
8-Nov-97	11	10.1	402.76	12000	20000	-13.8	19.563	197	0	1.02E-04	0.100685721
10-Nov-97	3.5	18.2	402.76	12000	20000	-28	21.864	277	0.5	3.41E-04	0.336375117
16-Nov-97	0	5.3	402.76	12000	20000	-24.8	75.949	282	0.2	2.81E-04	0.277304846
21-Nov-97	8	9.7	402.76	12000	20000	-25.9	37.974	257	0.1	2.62E-04	0.258370802
28-Nov-97	13.5	13.2	402.76	12000	20000	-15.9	59.839	272	0	2.17E-05	0.021399414
1-Dec-97	6	8.5	402.76	12000	20000	-18.2	28.769	247	0	2.06E-04	0.203245123
8-Dec-97	-0.5	5.6	402.76	12000	20000	20.2	80.552	282	0	1.64E-04	0.161728288
9-Dec-97			402.76	12000	20000	-20.1	113.92	247		6.91E-05	0.068142634
15-Dec-97	6	9.6	402.76	12000	20000	-13.8	13.809	317	0	1.16E-04	0.114491794
20-Dec-97	6.5	15.5	402.76	12000	20000	-19.3	56.386	192	0	1.17E-04	0.115477943
22-Dec-97	2.5	10.9	402.76	12000	20000	-21.7	33.371	267	0	1.97E-04	0.194369791
23-Dec-97	2.5	10.5	402.76	12000	20000	-22.2	51.783	237	0	1.35E-04	0.133228608
27-Dec-97	2	10.5	402.76	12000	20000	-27.7	44.879	237	0	2.36E-04	0.232730952
29-Dec-97	4.5	17	402.76	12000	20000	-30.5	97.813	322	0.2	2.18E-04	0.214980284
31-Dec-97	4	10.6	402.76	12000	20000	-20.6	73.647	307	0	1.73E-04	0.170603621
1-Jan-98	9	20.8	400	6000	20000	-19.5	28.769	262	0	8.40E-05	0.08285812
4-Jan-98	9	12.3	375	6000	20000	-22.8	56.388	217	0	6.53E-05	0.064395471
9-Jan-98	2.5	8.2	400	6000	20000	-22.3	44.879	265	0	1.69E-04	0.166654873
21-Jan-98	5	10.9	400	6000	20000	-21.9	56.688	43	0	1.28E-04	0.126228957
26-Jan-98	7.5	10.2	400	6000	20000	-19.5	51.783	267	0	9.12E-05	0.089938707
29-Jan-98	7.5	6.3	400	6000	20000	-25.3	28.769	297	0	1.48E-04	0.145456845
31-Jan-98	10.5	9.9	400	6000	5000	5.5	18.412	192	2	8.85E-04	0.873727217
1-Feb-98	9.5	8.4	345	6000	20000	-28	-29.9182	257	0	1.41E-04	0.139046882
4-Feb-98	2.5	10.5	400	6000	6000	-0.8	4.603	32	3	0.0058755	5.794113182
8-Feb-98	7	8	400	6000	20000	-29.6	13.809	227	0	4.15E-04	0.409251462
15-Feb-98	10.5	11	345	6000	20000	-22.2	-25.5455	152	0.1	2.77E-04	0.273163024
19-Feb-98	10	9.3	345	6000	20000	-30.2	-34.7511	242	3	5.64E-04	0.556187528
23-Feb-98	11.5	6.2	400	6000	20000	-24.3	75.949	267	0	1.70E-04	0.167743792
25-Feb-98	18	20.9	350	6000	5000	-16.1	-18.5263	257	1	2.64E-05	0.02603431
26-Feb-98	6	11.4	400	6000	20000	-36.2	24.166	287	0.5	2.67E-04	0.263104313

Conrd Table 2

date	Ground level conditions		aircraft condition			jettison altitude			Results of jettison run		
	Mean Temp	Wind Speed	Speed	Fuel Jettison	Altitude	Temp	wind speed	Direction	Ground fall	max deposition	
	Celsius	mph	mph	lbs	ft	Celsius	mph	degree	%	ml/m2	mg/m2
9-Mar-98	-2	21.5	350	6000	20000	-26.4	-30.37848	212	2	1.71E-04	0.168631325
10-Mar-98	-3	12	350	6000	20000	-28.9	-33.25523	282	2	4.38E-04	0.431932868
11-Mar-98	-1	10.7	350	6000	20000	-28.2	-32.44974	292	1	2.12E-04	0.208866168
12-Mar-98	-3	10.4	350	6000	20000	-21.8	-25.08526	292	1	1.97E-04	0.194271178
2-Apr-98	17	10	400	6000	20000	-19	49.482	222	0	3.68E-05	0.03629025
6-Apr-98	18	15.2	400	6000	20000	-16.8	49.482	222	0	4.56E-05	0.044919046
22-Apr-98	14	8.2	400	6000	20000	-25.9	51.783	357	0	1.03E-04	0.10127741
27-Apr-98	13	15.2	400	6000	20000	-20.5	21.864	347	0	8.57E-05	0.084512892
6-May-98	21	6.7	350	6000	20000	-13.7	-15.76459	275	0	1.59E-05	0.015679755
7-May-98	19	8.5	350	6000	20000	-12.1	-13.92347	275	0	4.03E-06	0.003974177
10-May-98	18	5.5	350	6000	20000	-15.7	-18.06599	287	0	2.36E-05	0.023273095
15-May-98	23	14.4	350	6000	20000	-12.2	-14.03854	212	0	3.87E-06	0.003816393
19-May-98	25.5	10.4	350	6000	20000	-13.1	-15.07417	272	0	8.44E-06	0.00832309
24-May-98	25	7.8	350	6000	20000	-14.9	-17.14543	222	0	2.47E-05	0.024357858
2-Jun-98	32.5	13.9	350	6000	20000	-7.6	-8.74532	267	0	3.84E-06	0.003786809
5-Jun-98	26.7	18.4	350	6000	20000	-11.5	-13.23305	237	0	5.89E-06	0.005808412
7-Jun-98	18.5	10.5	400	6000	20000	-14.3	42.577	282	0	2.17E-05	0.021399414
10-Jun-98	27.2	20	350	8000	20000	-10.9	-12.54263	247	0	6.06E-06	0.005977044
15-Jun-98	24	9.6	350	8000	20000	-16.3	-18.75641	247	0	1.48E-05	0.014614715
20-Jun-98	32	21.2	325	7000	20000	-8.9	-10.24123	267	0	8.19E-06	0.008104257
24-Jun-98	35	23.6	350	6000	20000	-8	-9.2056	302	0	7.04E-06	0.006943469
27-Jun-98	26.7	14.3	350	6000	20000	-4.6	-5.29322	67	0	7.25E-06	0.007149574
5-Aug-98	25.5	6.9	400	6000	20000	-7.6	28.769	247		2.36E-05	0.023273095
19-Aug-98	31	5.8	345	5000	20000	-8	-9.2056	137	0	1.44E-05	0.014210394
26-Aug-98	32	8.2	345	5000	20000	-5.6	-6.44392	157	0	1.14E-05	0.011242088
6-Sep-98	31.5	11.9	400	6000	20000	-7.4	11.507	52	0	1.07E-05	0.010532062
31-Oct-98	20.5	8.7	400	6000	6000	12.2	21.864	182	0	4.93E-04	0.486171013
6-Nov-98	6	6.3	400	6000	6000	1.3	13.809	197	3	5.54E-03	5.466514763
8-Nov-98	9	6.3	400	6000	6000	8	18.412	242	1.5	3.00E-03	2.958049841
11-Nov-98	9.5	10.6	400	6000	6000	1.6	19.563	242	1.5	2.16E-03	2.127121452
16-Nov-98	17.5	16.2	400	6000	6000	14.2	47.18	232	0.5	5.41E-04	0.533506122
27-Nov-98	15	11.7	400	6000	6000	13.2	18.412	232	0.1	8.00E-04	0.78891846
29-Nov-98	19	17.8	400	6000	6000	16.9	40.276	212	0.1	4.21E-04	0.41516835
2-Dec-98	12	14.3	350	6000	20000	-9.7	-11.16179	232	0	2.85E-06	0.002810522
3-Dec-98	18	14.4	345	6000	20000	-10.7	-12.31249	212	0	6.38E-06	0.006291625
6-Dec-98	12.5	14.8	345	6000	20000	-13.1	-15.07417	231	0	9.12E-06	0.008993671
15-Dec-98	9	8.9	350	6000	20000	-17.9	-20.59753	42	0	1.05E-04	0.103052476
18-Dec-98	9	18.9	350	5000	20000	-12.7	-14.61389	232	0.1	1.09E-05	0.010699707
21-Dec-98	-3.5	16	345	6000	20000	-15.1	-17.37557	242	0	2.66E-05	0.026231539
23-Dec-98	-7	9.2	345	6000	20000	-16.7	-19.21669	237	0.1	6.33E-05	0.06238359
9-Jan-99	-6.5	13.9	400	12000	20000	-26.4	40.276	282	0.5	2.33E-04	0.229772507
15-Jan-99	9	16.6	350	12000	20000	-17.1	-19.67697	257	0	7.36E-05	0.0725805
19-Jan-99	11	14.6	400	12000	20000	-19.6	64.441	237		2.84E-05	0.028006606
20-Jan-99	11.5	9	250	15000	20000	-13.9	-15.99473	262	2	6.81E-05	0.067156686
26-Jan-99	11	13.3	300	15000	20000	-11.3	-13.00291	217	0	9.86E-06	0.00972342
1-Feb-99	9	10.6	250	15000	20000	-15.6	-17.95092	242	2	6.97E-05	0.068734523
6-Feb-99	16	12.9	300	14000	20000	-14.3	-16.45501	243	0	2.58E-05	0.025442621
13-Feb-99	7	7.1	350	12000	20000	-14.3	-16.45501	212	0	2.01E-04	0.198215768
15-Feb-99	13	20.7	300	14000	20000	-14.3	-16.45501	252	0	4.60E-05	0.045362813
21-Feb-99	3	12.2	400	14000	20000	-15.3	-17.60571	302	1	1.65E-04	0.162832774
23-Feb-99	7	10.6	400	14000	20000	-29.1	-33.48537	292	1	1.64E-04	0.161728288
1-Mar-99	0.5	11.5	400	12000	20000	-26.8	-30.83876	262	0	9.01E-05	0.088851944
5-Mar-99	16.5	19.9	400	12000	20000	-33	-37.9731	257	0	4.82E-05	0.047532338
13-Mar-99	2	15.5	400	12000	20000	-23.5	-27.04145	200	2	2.89E-04	0.284996801
23-Mar-99	13	16	400	14000	20000	-17.1	-19.67697	262	0.1	1.14E-04	0.112223654
28-Mar-99	9	10.4	400	12000	20000	-24.5	-28.19215	222	0	6.38E-05	0.062916249
1-Apr-99	19	20.3	400	12000	20000	-18.4	33.371	212	0	1.56E-05	0.01538391
6-Apr-99	15.5	8.2	400	12000	20000	-18.9	40.276	257	0	6.63E-05	0.065381619
15-Apr-99	11	28.5	400	12000	20000	-22.2	13.809	37	0	1.54E-04	0.151866807
24-Apr-99	10.5	14.4	400	12000	20000	-13.2	42.577	227	0	3.65E-05	0.035994406
27-Apr-99	17	7.3	400	12000	20000	-24.2	44.879	242	0	8.49E-05	0.083723974
29-Apr-99	15.5	11.3	400	12000	20000	-14.9	18.412	237	0	2.53E-04	0.249495469
1-May-99	16.5	9.4	400	12000	20000	-14.4	24.166	147	0	1.02E-04	0.100665721
4-May-99	20.5	20.7	400	12000	20000	-16.4	59.839	217	0	2.32E-05	0.022878636
9-May-99	22	14.2	400	12000	20000	-15	19.563	277	0	1.02E-05	0.010068572
14-May-99	21	11.9	400	12000	20000	-14	24.166	237	0	1.77E-05	0.017464683
18-May-99	16.5	6.4	400	12000	20000	-15.1	64.441	262	0	3.30E-05	0.032542667
23-May-99	23	10.7	400	12000	20000	-11.4	42.577	237	0	1.82E-05	0.017947895
1-Jun-99	25	11.6	400	12000	20000	-13.8	44.879	247	0	5.03E-06	0.004961311
4-Jun-99	26	14.3	400	12000	20000	-12.5	31.07	227	0	6.04E-06	0.005956335
7-Jun-99	25	9.3	400	12000	20000	-11.5	9.2059	152	0	1.49E-05	0.014693607
16-Jun-99	21.5	9.3	400	12000	20000	-11.5	28.769	292	0	1.64E-05	0.016172829
20-Jun-99	24	7	400	12000	20000	-9.3	6.9044	82	0	2.11E-05	0.020807725
22-Jun-99	22.5	7.1	400	12000	20000	-10.6	16.11	202	0	1.36E-06	0.001341181
26-Jun-99	26	7.8	400	12000	20000	-9.1	19.563	322	0	1.26E-05	0.012425465
14-Jul-99	27	10.9	400	12000	20000	-8.8	4.603	317	0	1.38E-05	0.013608844
16-Jul-99	27.5	9.4	400	12000	20000	-7.3	11.507	167	0	1.29E-05	0.01272131
26-Jul-99	27.5	10	400	12000	20000	-6.7	11.507	112	0	1.05E-05	0.010354555
28-Jul-99	29.5	9.4	400	12000	20000	-8	13.809	122	0	9.29E-06	0.009161316
31-Jul-99	31	12	400	12000	20000	-11.7	28.769	292	0	1.22E-05	0.012031007
1-Aug-99	31	9.6	400	12000	20000	-8.5	26.467	177	0	7.91E-06	0.007800431
3-Aug-99	29	7.4	400	12000	20000	-8.3	9.2059	187	0	1.79E-05	0.017602744
6-Aug-99	31	8.7	400	12000	20000	-6.1	13.809	277	0	9.01E-06	0.008886181
14-Aug-99	26	9	400	12000	20000	-5.5	19.563	357	0	2.49E-05	0.024555088
20-Aug-99	26	7.5	400	12000	20000	-7.1	13.809	27	0	1.15E-05	0.011340703
24-Aug-99	29	7	400	12000	20000	-7.7	44.879	327	0	7.31E-06	0.007208743
1-Sep-99	28.5	10	400	12000	20000	-8.3	11.507	82	0	1.44E-05	0.014200533
3-Sep-99	28	9.1	400	12000	20000	-7.5	6.9044	307	0	2.15E-05	0.021202184
8-Sep-99	24	12.9	400	12000	20000	-9.5	33.371	292	0	1.26E-05	0.012425466
14-Sep-99	21.5	8.3	400	12000	20000	-13.9	24.166	242	0	6.04E-05	0.059563345
21-Sep-99	14.5	13.6	400	12000	20000	-12.8	44.879	287	0	4.01E-05	0.039544539
25-Sep-99	19.5	7.5	400	12000	20000	-12.4	24.166	277	0	1.88E-05	0.018549446
27-Sep-99	22.5	11.9	400	12000	20000	-9.4	33.371	227	0	7.22E-06	0.007119989

Cont'd Table 2

date	Ground level conditions		aircraft condition			jettison altitude			Results of jettison run		
	Mean Temp	Wind Speed	Speed	Fuel Jettisoned	Altitude	Temp	wind speed	Direction	Ground fall	max deposition	
	Celsius	mph	mph	lbs	ft	Celsius	mph	degrees	%	m/m2	mg/m2
5-Oct-99	16.5	4.5	400	12000	20000	-10.1	16.11	267	0	3.74E-05	0.036881839
10-Oct-99	22	2.8	400	12000	20000	-9.6	31.07	22	0	2.30E-05	0.022681406
17-Oct-99	13	19.3	400	12000	20000	-15.1	37.974	242	0	7.69E-05	0.075834789
25-Oct-99	16	11.2	400	12000	20000	-13.4	11.507	337	0	1.41E-06	0.001390469
29-Oct-99	20.5	18.9	400	12000	20000	-17.9	19.563	257	0	2.75E-05	0.027119073
31-Oct-99	13.5	12.3	400	12000	20000	-20.3	51.783	68	0	8.49E-05	0.083723974
2-Nov-99	9.5	17.8	400	12000	16000	-13.4	58.688	297	0	1.31E-04	0.129185401
5-Nov-99	16	16.3	400	12000	20000	-12.5	9.2059	237	0	1.14E-05	0.011242068
10-Nov-99	18.5	10	400	12000	20000	-13.9	28.769	252	0	1.80E-05	0.017750666
14-Nov-99	18	8.1	400	12000	20000	-11.9	9.2059	227	0	3.18E-05	0.031458124
20-Nov-99	11	6.1	400	12000	20000	-15.2	24.166	342	0	1.54E-04	0.151866807
22-Nov-99	17.5	9.3	400	12000	20000	-17.8	66.686	217	0	3.25E-05	0.032049813
24-Nov-99	5	7.4	400	12000	20000	-17.8	71.346	227	0	4.60E-05	0.045362813
26-Nov-99	10	11	400	12000	20000	-20.3	54.085	322	0	7.71E-05	0.076032019
28-Nov-99	10	8.9	400	12000	20000	-16.6	44.879	257	0	6.31E-05	0.062225945
2-Dec-99	16	21.2	400	12000	20000	-19.7	28.769	202	0	1.61E-06	0.001587698
4-Dec-99	12.5	11.6	400	12000	20000	-18.4	58.688	192	0	5.76E-05	0.056802131
10-Dec-99	5	9.7	400	12000	20000	-18.2	59.839	164	0	7.71E-05	0.076032019
14-Dec-99	6.5	16.6	400	12000	20000	-23.7	69.044	217	0	8.21E-05	0.080962759
20-Dec-99	0.5	12.9	400	12000	20000	-27.1	51.783	237	0.5	6.48E-04	0.636253589
30-Dec-99	9.5	13	400	12000	20000	-16.5	59.839	257	0	2.93E-05	0.028894139
31-Dec-99	8.5	8.1	400	12000	20000	-20.5	19.563	257	0	1.36E-04	0.134118142
16-Jan-00	13.5	10.6	400	12000	20000	-15.3	35.673	267	0	1.49E-05	0.014693607
18-Jan-00						-13.8	71.346	252		2.09E-04	0.206104953
21-Jan-00	4.5	11.4	400	12000	20000	-20.1	69.044	277	0	6.63E-05	0.067076877
23-Jan-00	7.5	9.2	400	12000	20000	-21.9	66.743	262	0	1.07E-04	0.105133249
25-Jan-00	0.5	13	400	12000	20000	-19.2	71.346	222	0	8.41E-05	0.082935055
26-Jan-00	-1.5	6.3	400	12000	20000	-0.9	9.2059	322	6	1.39E-04	0.137074586
28-Jan-00	-4.5	7.6	400	12000	5000	-28.8	33.371	267	1	7.88E-04	0.778112407
1-Feb-00	0	8.7	400	12000	20000	-25.8	44.879	277	0	2.16E-04	0.21300799
6-Feb-00	7.5	13.9	400	12000	20000	-25.8	42.577	272	0	2.28E-04	0.224841767
17-Feb-00	10.5	9.7	400	12000	20000	-19.3	47.18	247	0	6.41E-05	0.063212093
23-Feb-00	15.5	10.6	400	12000	20000	-27.9	44.879	237	0	6.29E-05	0.062028715
25-Feb-00	16.5	22.4	400	12000	20000	-18.6	54.085	217	0	1.78E-05	0.017553436
27-Feb-00	12.5	7	400	12000	20000	-27.4	56.386	312	0	1.77E-04	0.174548214
28-Feb-00	14.5	16	400	12000	20000	-27.4	47.18	287	0	1.99E-04	0.196243472
1-Mar-00	11.5	10.7	400	12000	20000	-18.7	44.879	277	0	1.28E-04	0.126424186
3-Mar-00	8.5	13.9	400	12000	20000	-22.7	92.059	262	0	1.19E-04	0.117450239
5-Mar-00	13	12	400	12000	20000	-16.6	25.467	227	0	9.42E-05	0.092895151
20-Mar-00	13.5	12.7	400	12000	20000	-19.6	42.577	257	0	6.25E-05	0.061357218
23-Mar-00	16	13.5	400	12000	20000	-17.3	73.647	187	0	3.06E-05	0.030176132
24-Mar-00	17	13.2	400	12000	20000	-14.5	54.085	247	0	2.71E-05	0.026724614
28-Mar-00	17.5	12.2	400	12000	20000	-19.1	59.839	312	0	4.24E-05	0.041812079
8-Apr-00	8	16.6	400	12000	20000	-18.1	89.758	302	0	7.72E-05	0.076160218
11-Apr-00	16	12.1	400	12000	20000	-18.7	24.166	262	0	3.11E-05	0.030668929
13-Apr-00	12	5.9	400	12000	20000	-19.2	31.07	252	0	1.36E-04	0.134017527
15-Apr-00	16.5	17.8	400	12000	20000	-18.2	19.563	262	0	5.39E-06	0.005315338
18-Apr-00	21	12.4	400	12000	20000	-41.1	31.07	277	0	2.66E-05	0.026231539
23-Apr-00	18.5	13.2	400	12000	20000	21.2	73.647	227	0	2.99E-05	0.029485828
21-May-00	22.5	8.2	400	12000	20000	-15.5	25.769	277	0	3.84E-05	0.037868087
22-May-00	26.5	10.9	400	12000	20000	-15.8	35.673	292	0	1.16E-05	0.011439318
28-May-00	23	7.1	400	12000	20000	-12.9	47.18	317	0	9.93E-06	0.009792461
18-Jun-00	18.5	6.8	400	12000	20000	-9.9	31.07	287	0	2.25E-05	0.022188332
20-Jun-00	23.5	7.8	400	12000	20000	-9.7	24.166	207	0	6.78E-06	0.006686084
25-Jun-00	26	8.4	400	12000	20000	-11.2	6.9044	207	0	1.02E-05	0.010029126
11-Jul-00	28.5	10.5	400	12000	5000	-6.4	13.809	227	0	3.84E-04	0.37868087
20-Jul-00	28.5	12	400	12000	20000	-8.2	16.11	267	0	8.71E-06	0.008587378
22-Jul-00	23.5	10.8	400	12000	20000	-11.3	33.371	21	0	1.10E-05	0.010847629
25-Jul-00	24.5	9.7	400	12000	20000	-8.2	47.18	342	0	1.39E-05	0.013707458
11-Aug-00	31	6.3	400	12000	20000	-8.4	4.603	347	0	1.67E-05	0.016478535
14-Aug-00	27.5	9.4	400	12000	20000	-6.7	24.166	227	0	1.32E-05	0.013017155
18-Aug-00	29	9	400	12000	20000	-7.3	16.11	257	0	9.67E-06	0.009536052
21-Aug-00	29.5	11.5	400	12000	20000	-8.2	16.11	312	0	8.34E-06	0.008225461
13-Sep-00	26	6.6	400	12000	20000	-6.6	13.809	357	0	1.98E-05	0.019525732
17-Sep-00	23	8.4	400	12000	20000	-9.1	19.563	352	0	1.22E-05	0.012031007
24-Sep-00	14.5	14.3	400	12000	20000	-7.1	44.879	247	0	1.24E-05	0.012228236
11-Oct-00	16	12.5	400	12000	20000	-11.5	26.467	277	0	3.87E-05	0.038163931
13-Oct-00	22.5	13.2	400	12000	20000	-11.5	28.769	222	0	4.73E-05	0.046644805
16-Oct-00	19.5	7.6	400	12000	5000	13	16.11	142	0.5	1.30E-03	1.281903777
24-Oct-00	20.5	8.6	400	12000	20000	-12.5	19.563	182	0	2.04E-05	0.020129116
27-Oct-00	20.5	8.5	400	12000	20000	-14.4	18.412	222	0	2.56E-05	0.025245381
29-Oct-00	19.5	13.6	400	12000	20000	-13.3	47.18	187	0	1.39E-05	0.013707499
30-Oct-00	20	9.1	400	12000	20000	-12.8	35.673	357	0	6.54E-06	0.006449409
1-Nov-00	19.5	15.2	400	12000	20000	-12.8	69.044	202	0	3.34E-06	0.003293735
5-Nov-00	14	9.1	400	12000	20000	-17.4	26.467	247	0	8.21E-05	0.080834101
9-Nov-00	2.5	11.6	400	12000	20000	-19.7	59.839	277	0	2.74E-04	0.270204579
13-Nov-00	1	10	400	12000	20000	-20	125.43	232	0.01	8.95E-05	0.088260255
15-Nov-00	4	14	400	12000	20000	-21.5	108.32	247	0.01	1.06E-04	0.104728928
21-Nov-00	5.5	8.9	400	12000	20000	-23.2	59.839	312	0.5	2.31E-04	0.227800211
23-Nov-00	10	7.7	400	12000	20000	-20.6	51.783	282	0.01	9.28E-05	0.091317314
25-Nov-00	7	10.1	400	12000	20000	-21.8	18.412	312	0	1.34E-04	0.132143845
1-Dec-00	7	12.9	400	12000	20000	-17	69.044	252	0	3.17E-05	0.031270756
12-Dec-00	-10.5	11	400	12000	20000	17.1	73.647	252	0.02	1.29E-04	0.127015875
17-Dec-00	-5	8.7	400	12000	5000	-6.9	56.386	322	5	5.43E-03	5.352121583
18-Dec-00	2.5	18.8	400	12000	20000	-16.2	62.14	267	0.1	7.11E-05	0.07011513
22-Dec-00	-2.5	11.5	400	12000	20000	-26.7	56.386	297	0.1	2.41E-04	0.237760307
25-Dec-00	-5	9.7	400	12000	20000	-27.9	54.085	242	0	1.63E-04	0.16074214
29-Dec-00	-1	9.7	400	12000	20000	-22.6	51.783	282	0	1.46E-04	0.144273467
7-Jan-01	5	10.4	400	12000	20000	-23.1	33.3	267	0	2.08E-04	0.20521742
15-Jan-01	5.5	5.5	325	12000	20000	-35.3	27	347	0	1.41E-04	0.139046882
16-Jan-01	4	9	400	12000	20000	-25.6	49.482	322	0	1.36E-04	0.133623068
21-Jan-01	3	5.3	400	12000	5000	1	19.51	212	5	0.0039149	3.860671197
29-Jan-01	3.5	12	400	12000	20000	-20.6	92	172	0.5	8.59E-05	0.084710122
1-Feb-01	4.5	6.9	400	12000	20000	-24.4	82.8	267	0.4	2.00E-04	0.197328236
2-Feb-01	0.5	9.5	400	12000	5000	-7.3	31	212	6	6.17E-03	6.080786414
4-Feb-01	8	12.5	400	12000	20000	-21.1	66.5	292	0	1.29E-04	0.127213105
7-Feb-01	11.5	10.7	400	12000	20000	-19.8	42.8	262	0	1.17E-04	0.115083483
10-Feb-01	-2.5	11	400	12000	5000	-7.8	35.6	327	8	5.11E-03	5.038033413
13-Feb-01	9.5	6.9	400	12000	20000	-19.8	54	232	0	7.32E-05	0.072166041
1-Mar-01	1.5	8.4	400	12000	20000	-18.7	76.2	232	0.01	9.46E-05	0.09328961
6-Mar-01	9.5	8.7	400	12000	20000	-28.2	28.7	272	0	2.20E-04	0.216952962
11-Mar-01	13	11.9	400	12000	20000	-21.9	56.3	247	0.01	8.75E-05	0.086287959
16-Mar-01	5	16.7	400	12000	20000	-24.5	66.7	272	0.01	1.87E-04	0.184409695
27-Mar-01	4	7	400	12000	20000	-24.8	49.4	287	0.01	4.25E-04	0.419112943
1-Apr-01	11.5	10.9	400	12000	20000	-28.3	71.3	297	0	1.48E-04	0.145949919
5-Apr-01	22.5	11.5	400	12000	20000	-12.8	21.8	232	0	1.43E-05	0.014101918
7-Apr-01	21.5	14.3	400	12000	5000	29	43.75	228	0	2.30E-04	0.226814083
11-Apr-01	18.5	16.9	400	12000	20000	-17.8	31.07	272	0	8.24E-05	0.081256803
13-Apr-01	17	8.6	400	12000	20000	-14.4	89.78	237	0	5.14E-05	0.050688012
16-Apr-01	15	10.4	400	12000	20000	-18.2	49.4	282	0	6.80E-05	0.067058071
18-Apr-01	11	9.8	400	12000	20000	-16.8	49.4	312	0	1.03E-04	0.101671889
1-May-01	21.5	12.7	400	12000	5000	-17.8	31.07	272	0	7.59E-04	0.748486408
4-May-01	21.4	13.2	400	12000	20000	-12.8	35.6	222	0	1.42E-05	0.014003303
7-May-01	15.5	4.6	400	12000	20000	-19	35.67	282	0	9.26E-05	0.091317314
11-May-01	21	10.7	400	12000	20000	-15.7	21.8	332	0	1.68E-05	0.016567288
13-May-01	21.5	7.5	400	12000	20000	-13.8	16.11	332	0	4.13E-05	0.040727917
24-May-01	15.5	10.1	400	12000	20000	-18.2	73.647	297	0	9.43E-06	0.009299377

Cont'd Table 2

date	Ground level conditic		aircraft condition			Jettison altitude			Results of jettison run		
	Mean Tem	Wind Spe	Speed	Fuel Jettis	Altitude	Temp	wind spee	Direction	Ground fa	max deposition	
	Celsius	mph	mph	lbs	ft	Celsius	mph	degree	%	ml/m2	mg/m2
1-Jun-01	15.5	10.1	400	12000	20000	18.2	42.557	297	0	1.19E-05	0.011735162
7-Jun-01	25	8.4	325	12000	20000	-14.3	37	282	0	1.07E-05	0.010571508
17-Jun-01	26	10.9	400	12000	20000	-10.1	18.412	282	0	1.43E-05	0.014101918
20-Jun-01	25.5	7.5	400	12000	20000	-10.7	13.89	2	0	1.32E-05	0.013017155
21-Jun-01	24.5	9	400	12000	20000	-22.7	40.276	277	0	1.30E-05	0.012815025
1-Jul-01	26.1	7.8	350	14000	20000	-14.1	34	38	0	1.55E-05	0.015255711
2-Jul-01	25.8	9	325	14000	20000	-8.1	34	32	0	9.25E-06	0.00912187
14-Jul-01	25	9.3	350	12000	20000	3.1	20	347	0	2.36E-05	0.023273095
23-Jul-01	32.5	15.3	350	12000	20000	-6.3	8	261	0	1.92E-04	0.189340435
1-Aug-01	30	9.3	400	12000	20000	-3.5	11.507	242	0	9.71E-06	0.009575498
6-Aug-01	30	8.3	350	15000	20000	-8	21	32	0	1.45E-05	0.014299147
11-Aug-01	27	5.9	400	12000	20000	-8.7	6.9044	135	0	8.27E-05	0.081554448
15-Aug-01	28	13.9	345	14000	20000	-6.6	16	287	0	1.13E-05	0.01114347
29-Aug-01	24.5	7.4	350	12000	20000	5.8	14	132	0	2.34E-05	0.023075000
31-Aug-01	24.5	6.6	350	12000	20000	-8.3	12	287	0	2.38E-05	0.023470325
5-Sep-01	24	5.6	400	12000	6000	12	19.563	0	0	3.65E-05	0.035994406
9-Sep-01	19.5	15	400	12000	6000	12	19.563	0	0.8	1.29E-03	1.275582567
4-Oct-01	22	12.7	400	12000	5000	14.5	25.316	187	0.5	7.51E-04	0.740597223
7-Oct-01	13	12.7	400	12000	5000	9.2	10.357	227	2	2.41E-03	2.372277869
8-Oct-01	16.5	16.9	400	12000	20000	-15.6	29.919	265	0	1.96E-05	0.019328503
19-Oct-01	13.5	5.4	400	12000	20000	11.2	6.9044	182	0.5	1.29E-04	0.127015875
25-Oct-01	12	9.6	400	12000	20000	12.4	97.613	277	0	1.53E-05	0.015088466
27-Oct-01	11.5	7.4	400	12000	20000	-16.2	26.467	307	0	2.04E-04	0.201272827
1-Nov-01	20.5	16.1	400	12000	20000	-11.7	40.276	232	0	4.94E-06	0.004871572
9-Nov-01	9	9.6	400	12000	20000	-33.9	20.713	242	0	2.53E-04	0.249495469
10-Nov-01	12.5	8.3	400	12000	20000	-16.9	18.412	272	0	1.31E-04	0.129264016
16-Nov-01	16	5.2	400	12000	20000	-13.1	16.11	157	0	1.63E-04	0.160445296
23-Nov-01	15	18.8	400	12000	20000	-14.1	25.316	242	0	3.56E-05	0.035108872
27-Nov-01	-1.5	18.1	400	12000	12000	5.1	97.613	227	0	1.76E-04	0.173582066
30-Nov-01	6	13	400	12000	12000	-0.6	85.236	247	1	6.86E-04	0.676497597
5-Dec-01	6	9.1	350	12000	20000	-18.3	69	208	0	1.42E-05	0.014003303
12-Dec-01	8.5	5.8	400	12000	16000	-9	60.989	187	0	6.25E-05	0.061218899
16-Dec-01	8	9.1	400	12000	16000	-9.2	69.044	207	0	7.75E-05	0.076426476
22-Dec-01	6	18	400	12000	20000	-21.1	104.72	227	0	4.56E-05	0.044968353
31-Dec-01	N/A	N/A	400	12000	16000	-22.4	65.592	257	0.5	2.95E-04	0.29081369
8-Jan-02	6.5	11	400	12000	20000	16.5	43.728	332	0	6.77E-05	0.066782226
12-Jan-02	7	11.6	345	12000	20000	19.3	22.20861	303	0	2.40E-05	0.023707
14-Jan-02	8.5	21.5	345	14000	20000	-25.8	29.68806	287	1	1.67E-04	0.164686733
15-Jan-02	9	9.8	325	12000	20000	-35.3	40.01971	347	0	8.06E-05	0.079483537
18-Jan-02	-0.5	8.4	345	15000	20000	-20.2	23.24414	252	0.5	1.96E-04	0.193285028
21-Jan-02	6	9.8	400	12000	20000	-16.5	72.497	282	0	4.43E-05	0.043656776
27-Jan-02	11.5	12.8	400	12000	20000	-15.8	12.658	212	0	6.68E-05	0.065874693
30-Jan-02	-0.5	15.7	400	12000	20000	-15.4	71.346	227	0	9.60E-05	0.094670216
1-Feb-02	0	9.3	250	15000	20000	-20.5	-23.58935	217	2	1.21E-04	0.11932392
4-Feb-02	2.5	7.9	350	12000	20000	-19.5	-22.69893	87	0.2	1.31E-04	0.129185401
9-Feb-02	5.5	19.4	400	12000	20000	21.7	82.853	232	0	9.48E-05	0.09348884
14-Feb-02	6	13.2	250	15000	20000	-24.8	-28.53736	322	5	2.97E-04	0.292885986
16-Feb-02	9	5.9	300	14000	20000	-24.8	-28.53736	282	0.1	1.73E-04	0.170603621
19-Feb-02	9	5.9	325	14000	20000	-19.8	66.743	202	0	5.92E-05	0.058379968
23-Feb-02	12.5	13.7	400	12000	20000	13.9	52.934	333	0	1.04E-04	0.102558017
27-Feb-02	-3	6.8	400	12000	20000	28.2	79.401	287	0.5	2.42E-04	0.23864784
3-Mar-02	-7.5	10.9	345	12000	20000	-21.2	-24.39484	257	0.1	8.62E-04	0.850059662
9-Mar-02	1.5	17.6	400	12000	16000	-11.7	92.059	267	0.1	1.96E-04	0.193285028
13-Mar-02	17	17.6	300	14000	20000	-15.7	-18.06599	282	0	1.52E-05	0.014989451
15-Mar-02	6.5	16.5	400	12000	20000	-17.2	84.004	242	0	7.10E-05	0.070016515
18-Mar-02	11.5	6.3	350	12000	20000	-16	-18.4112	282	0.1	7.98E-05	0.078753233
22-Mar-02	8	15.4	350	12000	20000	-20.5	-23.58935	272	0.1	1.19E-05	0.011735162
27-Mar-02	10.5	12	400	12000	16000	-10.3	38.125	272	0	1.01E-04	0.099314975
31-Mar-02	14	7.6	350	12000	20000	17.5	20.13725	212	0.2	9.64E-05	0.095064877
2-Apr-02	13	21.1	350	12000	20000	-15	-17.2605	98	0	2.57E-06	0.002534401
3-Apr-02	6.5	14.8	350	12000	20000	-18	-20.7126	272	0.1	1.41E-04	0.139046082
4-Apr-02	9	6.7	350	12000	20000	-20.4	-23.47428	272	0	2.53E-04	0.249495469
9-Apr-02	15	7.7	345	14000	20000	-26.8	-30.83876	312	0.1	1.64E-04	0.16145125
10-Apr-02	18	11.6	350	12000	8000	-18.9	-21.74823	307	0	3.00E-04	0.296238889
14-Apr-02	21.5	8.8	350	12000	20000	-31.7	-36.47719	267	0	4.68E-05	0.046151731
17-Apr-02	24.5	18.2	350	12000	20000	-28	-32.2196	202	0	9.52E-06	0.00938013
1-May-02	28.5	10.6	400	12000	20000	-13.4	57.537	257	0	6.28E-06	0.00619301
9-May-02	16.5	8.2	350	12000	20000	-14	16.1098	215	0	5.02E-05	0.049514496
11-May-02	22.5	15.5	400	12000	20000	-12.2	17.974	222	0	4.33E-06	0.004270021
15-May-02	19	12.4	400	12000	20000	-17.1	35.673	247	0	4.33E-05	0.042700213
24-May-02	18.5	10.6	350	12000	20000	13.7	15.76459	260	0	2.81E-05	0.027710762
11-Jun-02	28	18.4	345	12000	20000	-10.7	12.31249	322	0	1.01E-05	0.009931498
18-Jun-02	23	14.6	350	12000	20000	-16.3	-18.75641	247	0	1.79E-05	0.017652051
24-Jun-02	25.5	9.4	345	12000	20000	-8.6	-9.89602	12	0	1.66E-05	0.016370058
28-Jun-02	27	8.6	350	12000	20000	-8.8	-10.12616	62	0	2.14E-05	0.021103565
29-Jun-02	27.5	12.4	345	12000	20000	-8.2	-9.43574	62	0	1.81E-05	0.017849281
1-Jul-02	22	8.5	400	12000	20000	-8.1	2.3015	317	0	1.62E-05	0.015975590
5-Jul-02	26	7.6	400	12000	20000	-8.6	17.261	167	0	9.68E-06	0.009545914
16-Jul-02	26	8.7	400	12000	20000	-10.1	10.357	217	0	2.67E-05	0.026330154
24-Jul-02	29	5.8	400	12000	20000	-11.2	18.412	272	0	1.96E-05	0.019220028
26-Jul-02	28	12.2	400	12000	20000	7.4	14.96	212	0	8.06E-06	0.007946381
31-Jul-02	27.5	10.4	400	12000	20000	-6	6.9044	107	0	9.76E-06	0.009624805
1-Aug-02	30	9.3	350	12000	20000	-3.5	-4.02745	42	0	1.00E-05	0.009861481
8-Aug-02	28	6	400	12000	20000	-5.2	9.2059	132	0	8.66E-06	0.008540043
11-Aug-02	27.5	10.4	400	12000	20000		0		0	6.84E-06	0.006745253
14-Aug-02	22	6.4	400	12000	20000	-10.7	28.769	317	0	2.68E-05	0.026428789
18-Aug-02	29.5	12.9	400	12000	20000	-10	5.7537	2	0	6.85E-06	0.006755114
23-Aug-02	30	9.3	400	12000	20000	-9.5	11.507	272	0	9.28E-06	0.009151454
2-Sep-02	28.5	10.6	400	12000	20000	-1	5.7537	322	0	9.69E-06	0.009555775
7-Sep-02	28.5	7.1	400	12000	20000	-8.4	9.2056	67	0	2.14E-05	0.021103569
15-Sep-02	21.5	10.3	400	12000	20000	-4.3	10.357	312	0	1.77E-04	0.174548214
18-Sep-02	26	14.7	400	12000	20000	-9	29.919	237	0	5.49E-06	0.005413853
25-Sep-02	20	2.5	400	12000	20000	-14.5	6.9044	312	0	4.59E-05	0.045264198
28-Sep-02	25	5.8	400	12000	20000	10.1	20.713	222	0	1.75E-05	0.017257592
1-Oct-02	24.5	10.8	400	12000	20000	12.2	27.616	237	0	9.03E-06	0.008905903
6-Oct-02	24	8.5	400	12000	20000	-8.7	36.824	212	0	9.21E-06	0.009082424
17-Oct-02	12	4.8	400	12000	20000	-19.9	64.441	277	0	9.54E-05	0.094078529
20-Oct-02	12.5	6.8	400	12000	20000	-18.4	17.261	307	0	2.82E-04	0.278093744
22-Oct-02	15	5.9	400	12000	20000	-19.1	33.371	272	0	1.28E-04	0.126226957
23-Oct-02	10.5	7.8	400	12000	20000	-15.7	49.462	272	0	9.81E-05	0.096741129
1-Nov-02	4	9.8	400	12000	20000	-18.6	55.236	257	0.5	1.12E-04	0.110448587
4-Nov-02	5.5	4.3	400	12000	20000	-12.5	58.688	252	0	5.28E-05	0.05206862
7-Nov-02	12.5	11.6	400	12000	20000	-19.1	49.462	307	0	6.82E-05	0.0672553
16-Nov-02	7.5	6.1	400	12000	20000	-27.7	23.015	297	0	1.68E-04	0.165672881
18-Nov-02	12.5	13	400	12000	20000	-17.1	57.537	282	0	2.55E-05	0.025146777
20-Nov-02	12	7.1	400	12000	20000	-22.5	64.086	242	0	8.34E-05	0.082244752
25-Nov-02	1	14.1	400	12000	20000	-22.5	59.839	242	0	1.09E-04	0.107588758
5-Dec-02	-3.5	8	400	12000	20000	-24.6	36.824	277	0	4.15E-04	0.409251462
11-Dec-02	5.5	10.8	400	12000	20000	-22.1	18.412	327	0	2.68E-04	0.264583535
15-Dec-02	9.5	8.9	400	12000	20000	-17.1	44.873	352	0	7.80E-05	0.076899829
18-Dec-02	11	7.5	400	12000	20000	-22.8	92.059	222	0	4.70E-05	0.046348961
20-Dec-02	5	6.2	400	12000	20000	-35.3	25.316	287	0	3.56E-04	0.351068724
24-Dec-02	-5	14.6	400	12000	20000	-24.5	72.497	302	0	1.39E-04	0.137074586
26-Dec-02	3	8.8	400	12000	20000	-24.2	84.004	282	0	1.59E-04	0.156797548
31-Dec-02	-4	4.6	400	12000	20000	-22.4	65.592	257	0.5	2.95E-04	0.29081369

TABLE 3:
Summary runs for E3A

date	Ground level condition		aircraft condition			jettison altitude			Results of jettison run		
	Mean Temp	Wind Speed	Speed	Fuel Jettisoned	Altitude	Temp	wind speed	Direction	Ground fall (%)	max deposition	
	Celsius	mph	mph	lbs	ft	Celsius	mph	degree	%	ml/m2	mg/m2
1-Jan-96	4.4	16.8	400	12000	20000	-36.1	65.592	227	0.1	3.08E-05	0.079680766
2-Jan-96	-0.1	21.3	400	12000	20000	-26.9	31.07	182	0.1	1.71E-04	0.168631325
6-Jan-96	-4.8	18	400	12000	20000	-31.7	54.004	247	0.1	1.44E-04	0.2296
10-Jan-96	7.7	9.8	400	12000	20000	-41.8	44.879	282	0.1	2.04E-04	0.200179753
14-Jan-96	10.2	9.2	400	12000	20000	-15.9	43.728	277	0	6.34E-06	0.006646638
17-Jan-96	13.9	16	400	12000	20000	-22.4	34.522	242	0	2.25E-05	0.022188332
21-Jan-96	4.1	10.7	400	12000	20000	-33	57.537	287	0	1.28E-04	0.126128342
24-Jan-96	2.7	6.7	400	12000	20000	-35.8	117.38	282	0	9.00E-05	0.088753329
27-Jan-96	-0.6	9.3	400	12000	20000	-16.1	44.879	302	0	5.20E-05	0.051279701
28-Jan-96	6.4	22.2	400	12000	20000	-19.4	90.909	252	0	3.77E-05	0.037177783
30-Jan-96	-5.3	16.2	400	12000	20000	-18.6	52.934	256	0	6.23E-05	0.061437027
31-Jan-96	-10.3	13.5	400	12000	20000	-20.4	63.291	277	0	1.29E-04	0.127213105
1-Feb-96	-10	10.1	400	12000	20000	-22.4	80.552	252	0	1.02E-04	0.100094032
3-Feb-96	-14.5	13.3	400	12000	20000	-28.9	57.537	262	2	4.07E-04	0.400869303
8-Feb-96	14.4	9.4	400	12000	20000	-19.9	63.291	282	0.1	5.97E-05	0.058873042
11-Feb-96	6.9	16.5	400	12000	20000	-19.9	63.291	277	0.1	7.53E-05	0.0742108
14-Feb-96	15.8	6.9	400	12000	20000	-17.4	41.427	282	0	3.83E-05	0.037769477
17-Feb-96	7.7	13.3	400	12000	20000	-19.3	66.743	312	0	1.04E-04	0.102756632
20-Feb-96	16.1	10.2	400	12000	20000	-29.5	66.743	312	0	7.96E-06	0.007844808
22-Feb-96	21.9	10	400	12000	20000	15.8	55.236	282	0	6.96E-06	0.006863591
26-Feb-96	20.5	12.2	400	12000	20000	-18.1	90.909	207	0	7.89E-06	0.007780709
28-Feb-96	-0.9	20.4	400	12000	20000	-23.7	101.27	217	1	1.29E-04	0.127213105
1-Mar-96	7	8.5	400	12000	20000	-32.4	59.839	252	0.5	1.43E-04	0.141019878
4-Mar-96	14.4	17.1	400	12000	20000	-23.1	46.03	272	0	1.43E-04	0.141117793
7-Mar-96	-5.9	24.1	400	12000	20000	-34.8	39.125	282	1.5	5.61E-05	0.05533277
9-Mar-96	-2.3	5.5	400	12000	20000	-31.9	57.537	312	1	3.83E-04	0.377990567
14-Mar-96	20.7	15.5	400	12000	20000	-22.4	29.919	207	0	1.98E-05	0.019525732
18-Mar-96	10.5	18.2	400	12000	20000	-28.1	19.563	207	0.5	1.30E-04	0.134313371
22-Mar-96	12.7	9.7	400	12000	20000	-22.6	42.577	302	0	9.10E-05	0.089730477
27-Mar-96	2.2	6.8	400	12000	20000	-20.8	59.839	342	0	7.03E-05	0.078221267
29-Mar-96	11.4	12.7	400	12000	20000	-20.7	34.522	207	0	5.08E-05	0.050096323
31-Mar-96	8	18.9	400	12000	20000	-21.8	46.03	277	0	4.90E-05	0.048321257
1-Apr-96	11.1	7.8	400	12000	20000	-21.5	46.03	322	0	5.68E-05	0.056013212
3-Apr-96	17.7	19.6	400	12000	20000	17.8	13.809	232	0	3.17E-05	0.031260895
6-Apr-96	8	6.9	400	12000	20000	-23.7	14.96	292	0	1.09E-04	0.107292913
9-Apr-96	16.3	7.5	400	12000	20000	-18.6	44.879	322	0	3.77E-05	0.037177783
11-Apr-96	21.9	20.7	400	12000	20000	17.4	78.769	277	0	5.32E-06	0.005246308
15-Apr-96	10.5	21.2	400	12000	5000	-0.3	55.236	342	5	1.56E-03	1.537306273
20-Apr-96	16.9	10	400	12000	20000	-19.3	70.195	252	0	4.59E-05	0.045264198
24-Apr-96	19.2	18.3	400	12000	20000	-16.3	56.386	307	0	4.26E-05	0.042009909
28-Apr-96	18	16.8	400	12000	20000	-15	58.688	212	0	2.65E-06	0.002613297
30-Apr-96	13.3	11.3	400	12000	20000	-18.5	85.155	292	0	4.71E-05	0.046447576
1-May-96	17.2	8.6	400	12000	20000	-19	60.989	277	0	4.62E-05	0.045569904
3-May-96	23	12.7	400	12000	20000	-14.8	41.427	262	0	7.34E-06	0.007238327
6-May-96	23.5	9.1	400	12000	20000	-12.8	8.0552	254	0	2.87E-04	0.283024505
9-May-96	23.8	19.5	400	12000	20000	-23.1	14.96	117	0	6.71E-06	0.006617054
11-May-96	14.1	13.1	400	12000	20000	23.1	41.427	282	0	6.42E-06	0.006331071
15-May-96	25.5	18.3	400	12000	20000	-14.4	13.809	282	0	4.72E-06	0.004654619
20-May-96	26.6	18.6	400	12000	20000	-7.4	28.769	262	0	2.89E-06	0.002851053
24-May-96	26.9	15.8	400	12000	20000	-12.2	40.276	177	0	3.02E-06	0.002974223
29-May-96	18.1	9.7	400	12000	20000	-12.2	50.633	217	0	8.86E-06	0.008737272
31-May-96	23.3	10.2	400	12000	20000	-13.7	10.357	147	0	9.98E-06	0.009841756
2-Jun-96	22.2	4.8	400	12000	20000	-14.8	32.371	292	0	4.13E-05	0.040727917
5-Jun-96	24.4	11.3	400	12000	20000	-14.1	33.371	307	0	4.74E-06	0.004674342
8-Jun-96	18.5	13.2	400	12000	20000	-16.4	58.607	307	0	1.65E-05	0.016271444
11-Jun-96	23.8	7.3	400	12000	20000	-10.4	23.015	317	0	1.92E-05	0.018934044
14-Jun-96	26.7	7.3	400	12000	20000	-7.5	6.9044	102	0	2.62E-05	0.025866665
18-Jun-96	29.4	9	400	12000	20000	-18.1	10.357	287	0	1.74E-05	0.017158977
22-Jun-96	28.2	8.9	400	12000	20000	-7.4	16.11	232	0	1.48E-05	0.014594992
27-Jun-96	28.3	10.4	400	12000	20000	-3.6	13.809	167	0	5.79E-06	0.005709797
29-Jun-96	29.7	9.2	400	12000	20000	-4.7	24.166	112	0	1.85E-05	0.018243174
1-Aug-96	24.5	8.6	400	12000	20000	-8	16.11	287	0	7.83E-06	0.00772154
3-Aug-96	24.5	11.3	400	12000	20000	-8.5	49.482	302	0	4.25E-06	0.004191129
5-Aug-96	30	15.5	400	12000	20000	-4.9	19.563	172	0	2.98E-06	0.002938721
6-Aug-96	28	13.2	400	12000	20000	-7.2	14.96	157	0	3.91E-06	0.003855839
8-Aug-96	27	9.1	400	12000	20000	-8.3	8.0552	192	0	1.75E-05	0.017257592
10-Aug-96	24.5	7.7	400	12000	20000	8.1	42.577	252	0	1.11E-05	0.010965967
12-Aug-96	22	7.9	400	12000	20000	-8.1	42.577	2	0	7.02E-06	0.00692069
15-Aug-96	25.5	7.1	400	12000	20000	-9.8	32.221	357	0	1.83E-05	0.01804651
17-Aug-96	25.5	5.8	400	12000	20000	-7.2	14.96	137	0	3.83E-06	0.003776947
18-Aug-96	27	8.9	400	12000	20000	-8.2	14.96	307	0	9.78E-06	0.009642516
1-Sep-96	24.5	5.6	400	12000	20000	-11.8	13.809	328	0	4.89E-05	0.048222642
3-Sep-96	23.5	7.6	400	12000	20000	13.2	5.7537	7	0	1.07E-05	0.010541913
5-Sep-96	26.5	8	400	12000	20000	-9	19.563	97	0	1.35E-05	0.013312999
7-Sep-96	25	9.1	400	12000	20000	-7.6	16.11	237	0	7.89E-06	0.007776764
10-Sep-96	27	4.5	400	12000	20000	11.3	21.864	12	0	1.37E-05	0.013510229
12-Sep-96	23.5	6	400	12000	20000	-10.3	24.166	257	0	1.98E-05	0.019525732
16-Sep-96	19	11.7	400	12000	20000	-8	35.673	292	0	7.00E-06	0.006902059
21-Sep-96	18.5	6.1	400	12000	20000	-10.8	62.14	307	0	1.97E-05	0.019427118
26-Sep-96	16	17	400	12000	20000	-9.7	51.783	222	0	6.17E-06	0.006084534
29-Sep-96	17.5	7.8	400	12000	20000	-10.6	26.467	307	0	1.49E-05	0.014664299
1-Oct-96	18.5	12	400	12000	20000	-9.5	10.357	307	0	1.33E-05	0.013145354
5-Oct-96	17.5	7.1	400	12000	20000	-13.4	9.2059	192	0	1.98E-05	0.019503054
8-Oct-96	16	11.7	400	12000	20000	-13.5	58.688	337	0	3.20E-05	0.031556739
11-Oct-96	16.5	11.4	400	12000	20000	-11.9	12.658	312	0	1.18E-05	0.011636548
14-Oct-96	19	13.6	400	12000	20000	-14.1	34.522	312	0	5.10E-06	0.005032318
18-Oct-96	11	8.3	400	12000	20000	-14.7	71.346	292	0	4.67E-05	0.046003809
21-Oct-96	14.5	12.5	400	12000	20000	-16.8	47.18	217	0	2.77E-05	0.027276856
24-Oct-96	14.3	12	400	12000	20000	-19.9	46.03	222	0	3.98E-05	0.039248694
28-Oct-96	10.5	8.4	400	12000	20000	-10.3	41.427	247	0	2.03E-05	0.020048191
30-Oct-96	13	8.1	400	12000	20000	15.6	58.688	262	0	2.65E-05	0.026132925
4-Nov-96	14	18	400	12000	20000	-15.2	73.647	212	0	2.55E-05	0.025156038
11-Nov-96	8	9	400	12000	20000	-16.8	57.537	312	0	3.66E-05	0.03609302
13-Nov-96	8	6.8	400	12000	20000	-15	31.07	262	0	3.73E-05	0.036803047
15-Nov-96	14.5	14.8	400	12000	20000	-19	51.783	202	0.1	3.09E-05	0.030471976
17-Nov-96	6	12.4	400	12000	5000	2.8	35.673	317	4	1.52E-03	1.49460606
20-Nov-96	13	8.4	400	12000	20000	-11.6	49.482	292	0	1.09E-05	0.010758876
23-Nov-96	14	15.8	400	12000	20000	-15	42.728	322	0	8.13E-06	0.008020342
25-Nov-96	-0.5	20.9	400	12000	20000	-21.4	28.769	327	0.1	7.26E-05	0.071545045
27-Nov-96	0.5	6.4	400	12000	20000	-21.3	56.386	237	0.1	9.21E-05	0.09082424
30-Nov-96	5.5	9.6	400	12000	20000	-23.7	84.004	217	0	4.71E-05	0.046447576

Cont'd Table 3

date	Ground level condition		aircraft condition			jettison altitude			Results of jettison run		
	Mean Temp Celsius	Wind Speed mph	Speed mph	Fuel Jettisoned lbs	Altitude ft	Temp Celsius	wind speed mph	Direction degree	Ground fall (%) %	max deposition ml/m2	mg/m2
1-Jan-97	15	9.7	402.76	12000	20000	-13.5	33.371	0	0.1	2.80E-05	0.027602285
3-Jan-97	7.5	13.2	402.76	12000	20000	-19.4	96.662	270	0.1	5.75E-05	0.056703516
8-Jan-97	0	7.3	402.76	12000	20000	-25.5	94.361	217	0.2	9.00E-05	0.08876319
15-Jan-97	0.5	19.6	402.76	12000	20000	-27.9	118.53	242	0.2	6.47E-05	0.063803782
16-Jan-97	-2.5	15.7	402.76	12000	20000	-24.1	56.386	257	0.1	1.04E-04	0.102362173
21-Jan-97	15.5	21.3	402.76	12000	20000	-18	51.07	207	0.1	2.22E-05	0.021892488
23-Jan-97	11	0.3	402.76	12000	20000	-19.4	64.441	232	0	4.95E-05	0.048814331
27-Jan-97	-1.5	17.1	402.76	12000	20000	-21.1	39.839	242	0	3.53E-05	0.034781443
29-Jan-97	0	9.7	402.76	12000	20000	-22.7	9.2059	217	0.1	1.76E-04	0.173562066
1-Feb-97	12.5	5.3	402.76	12000	20000	-14.8	28.769	352	0	4.68E-05	0.046151734
4-Feb-97	10	16	402.76	12000	20000	-19.9	75.949	257	0	4.34E-05	0.042798828
8-Feb-97	-1.5	13.6	402.76	12000	20000	-23.1	82.853	272	0.5	2.17E-04	0.213994138
10-Feb-97	2.5	6.9	402.76	12000	20000	-26.2	35.673	297	0.4	2.08E-04	0.205118000
15-Feb-97	7	10.4	402.76	12000	20000	-27.4	36.386	302	0.1	1.30E-04	0.128366898
18-Feb-97	13.5	20.8	402.76	12000	20000	-17.1	40.276	237	0	8.83E-06	0.008707008
23-Feb-97	8	7.8	402.76	12000	20000	-23.8	71.346	257	0.1	1.16E-04	0.11439318
26-Feb-97	5	8.4	402.76	12000	20000	-18.2	87.456	232	0	4.05E-05	0.039938998
28-Feb-97	10	12.4	402.76	12000	20000	-19.9	64.441	227	0	3.68E-05	0.03629625
1-Mar-97	11	12.4	402.76	12000	20000	-29.4	75.949	217	0	3.33E-05	0.032838732
3-Mar-97	10.5	10.8	402.76	12000	20000	-13.8	56.386	247	0	7.62E-05	0.075600561
6-Mar-97	8.3	18.3	402.76	12000	20000	-23.3	62.14	267	0	7.25E-05	0.071495777
10-Mar-97	12	7.1	402.76	12000	20000	-18.2	40.276	362	0	6.08E-05	0.059960375
12-Mar-97	16.5	10.2	402.76	12000	20000	-18.3	19.563	102	0	3.42E-05	0.033726265
20-Mar-97	15	6.7	402.76	12000	20000	-16.4	44.879	22	0	2.87E-05	0.028303245
21-Mar-97	21.5	12.9	402.76	12000	20000	-13.7	21.864	307	0	1.16E-05	0.011439318
26-Mar-97	11	6	402.76	12000	20000	-21.5	51.783	37	0	8.33E-05	0.082146137
28-Mar-97	16	19.8	402.76	12000	20000	-20.2	66.743	252	0	2.80E-05	0.02849968
31-Mar-97	11.5	9.6	402.76	12000	20000	-20.7	21.866	252	0	9.36E-05	0.092303462
1-Apr-97	18.5	9.6	402.76	12000	20000	-19.4	21.864	202	0	4.91E-05	0.048419972
3-Apr-97	19	16.1	402.76	12000	20000	-19.2	102.42	162	0	2.68E-05	0.026428709
8-Apr-97	9.5	13	402.76	12000	20000	-22.1	47.18	227	0	4.40E-05	0.043082205
12-Apr-97	0.5	10.9	402.76	12000	20000	-29.3	49.481	247	0	1.41E-04	0.139047298
16-Apr-97	15	11	402.76	12000	20000	-21.6	19.563	262	0	1.00E-04	0.09861204
22-Apr-97	16.5	13.3	402.76	12000	20000	-17.6	51.783	272	0	5.02E-05	0.049504635
24-Apr-97	12	6.9	402.76	12000	20000	-20.5	26.467	262	0	8.97E-05	0.088487869
26-Apr-97	10.5	11.9	402.76	12000	5000	-4.7	31.07	231	0	7.16E-04	0.706082204
3-May-97	13	13.5	402.76	12000	20000	-20.1	95.155	277	0	4.56E-05	0.044968353
5-May-97	20	13.3	402.76	12000	20000	-15.2	33.371	267	0	4.78E-06	0.004713788
15-May-97	20	7	402.76	12000	20000	-17.3	42.577	297	0	3.30E-05	0.032542867
23-May-97	20	9.7	402.76	12000	20000	-9.9	26.467	322	0	1.04E-05	0.010285525
5-Jun-97	20	6.6	402.76	12000	20000	-10.6	33.371	342	0	1.07E-05	0.010551785
8-Jun-97	22.5	7	402.76	12000	20000	-12.2	9.2059	282	0	1.87E-05	0.018440960
22-Jun-97	25	15	402.76	12000	20000	-29.4	21.864	97	0	5.51E-05	0.054632665
1-Jul-97	28.5	17	402.76	12000	20000	-5	26.467	310	0	2.00E-06	0.001970124
7-Jul-97	23.5	9.4	402.76	12000	20000	-10.7	18.412	312	0	1.92E-05	0.018934044
14-Jul-97	30.5	10.1	402.76	12000	20000	-9.5	9.2059	352	0	9.72E-06	0.009585536
21-Jul-97	20	10.5	402.76	12000	20000	-7	13.808	137	0	5.99E-06	0.005697027
31-Jul-97	24.5	6.2	402.76	12000	20000	-5.5	11.507	37	0	1.27E-05	0.01252401
2-Aug-97	16.5	8.2	402.76	12000	20000	-5.4	6.9044	17	0	1.51E-05	0.014841529
2-Aug-97			402.76	12000	20000	-5.4	6.9044	17	0	8.75E-06	0.008638617
11-Aug-97	25	7.7	402.76	12000	20000	-6.4	26.467	227	0	4.65E-06	0.004585869
17-Aug-97	27.5	11.6	402.76	12000	20000	-10	26.467	257	0	1.11E-06	0.001106167
24-Aug-97	24	8.4	402.76	12000	20000	-8.9	11.507	342	0	1.62E-05	0.016005184
31-Aug-97	24	7.9	402.76	12000	20000	-10.1	13.809	312	0	6.39E-06	0.006301486
1-Sep-97	28	7.1	402.76	12000	20000	-7.1	13.809	357	0	7.33E-06	0.007428654
4-Sep-97	22	8.1	402.76	12000	20000	-6.8	4.603	62	0	1.88E-05	0.018557603
9-Sep-97	26	9.9	402.76	12000	20000	-11.4	42.577	317	0	7.52E-06	0.007438792
17-Sep-97	29	11.6	402.76	12000	20000	-7.6	28.769	247	0	3.83E-06	0.003779906
19-Sep-97	29	16.9	402.76	12000	20000	-6.8	16.11	252	0	3.49E-06	0.003439685
23-Sep-97	20.5	8.9	402.76	12000	20000	-8.2	42.577	297	0	5.80E-06	0.005709537
26-Sep-97	19.5	6.7	402.76	12000	20000	-7.9	4.603	47	0	1.18E-05	0.011636548
2-Oct-97	26	12.9	402.76	12000	20000	-11.4	6.9044	117	0	1.10E-05	0.010847629
5-Oct-97	23	13.1	402.76	12000	20000	-8.6	11.507	147	0	2.11E-05	0.020807725
10-Oct-97	20.5	8.3	402.76	12000	20000	-8.8	16.11	162	0	1.70E-05	0.016764518
13-Oct-97	12.5	13.9	402.76	12000	6000	4.5	40.276	327	1	5.15E-04	0.507106272
17-Oct-97	14	7.7	402.76	12000	20000	-20.5	23.864	252	0	7.49E-05	0.073862407
24-Oct-97	14	6.7	402.76	12000	20000	-20	54.085	242	0	3.62E-05	0.035698364
30-Oct-97	18	14	402.76	12000	20000	-17.6	28.769	232	0	2.34E-05	0.023115311
2-Nov-97	13	13.8	402.76	12000	20000	-29.4	87.456	297	0	8.72E-05	0.085992114
8-Nov-97	11	10.1	402.76	12000	20000	-13.8	19.563	197	0	5.72E-05	0.056407671
10-Nov-97	1.5	18.2	402.76	12000	20000	-26	21.464	277	0.3	1.98E-04	0.185099998
16-Nov-97	0	5.3	402.76	12000	20000	-24.8	75.949	282	0.2	1.52E-04	0.149894511
21-Nov-97	8	8.7	402.76	12000	20000	-25.9	37.978	257	0.1	1.24E-05	0.012228236
1-Dec-97	8	9.5	402.76	12000	20000	-18.2	28.769	247	0	1.82E-04	0.179478954
6-Dec-97	-0.5	5.8	402.76	12000	20000	-20.2	91.552	282	0	9.02E-05	0.088950559
9-Dec-97			402.76	12000	20000	-20.1	113.92	247		3.81E-05	0.037572143
15-Dec-97	8	9.8	402.76	12000	20000	-13.8	13.809	317	0	6.45E-05	0.063606552
20-Dec-97	6.5	15.5	402.76	12000	20000	-19.3	56.386	192	0	6.55E-05	0.064592978
22-Dec-97	2.5	10.9	402.76	12000	20000	-21.7	33.371	267	0	1.09E-04	0.107095684
23-Dec-97	2.5	10.5	402.76	12000	20000	-22.2	51.783	237	0	7.42E-05	0.07118205
27-Dec-97	2	10.5	402.76	12000	20000	-27.7	44.679	232	0	1.30E-04	0.128297468
29-Dec-97	4.5	17	402.76	12000	20000	-30.5	97.813	322	0.2	1.20E-04	0.118535002
31-Dec-97	4	10.4	402.76	12000	20000	-20.6	73.647	707	0	9.59E-05	0.094574607
1-Jan-98	9	20.8	400	6000	20000	-19.5	28.769	262	0	4.66E-05	0.045957083
4-Jan-98	0	12.3	375	6000	20000	-22.6	56.386	217	0	6.03E-05	0.05946473
9-Jan-98	2.5	8.2	400	6000	20000	-22.3	44.879	265	0	9.36E-05	0.092303462
14-Jan-98	-2	7.6	350	6000	20000	-27.4	28.76	252	0	5.94E-04	0.585771971
21-Jan-98	5	10.9	400	6000	20000	-21.9	58.688	43	0	7.10E-05	0.070616515
26-Jan-98	7.5	10.2	400	6000	20000	-19.5	51.783	267	0	5.10E-05	0.050254197
29-Jan-98	7.5	6.3	400	6000	20000	-25.3	28.769	297	0	8.91E-05	0.087865796
31-Jan-98	10.5	9.9	400	6000	6000	5.5	18.412	192	2	4.99E-04	0.492087502
1-Feb-98	9.5	9.4	345	6000	20000	-26	21.86	257	0	7.08E-05	0.069819285
4-Feb-98	2.5	10.5	400	6000	6000	-4.8	4.603	32	3	0.0032323	3.187526504
8-Feb-98	7	6	400	6000	20000	-29.6	13.809	227	0	2.20E-04	0.223827613
9-Feb-98	9.5	10.8	350	6000	20000	-27.5	45.27	237	0	5.25E-05	0.051772735
15-Feb-98	10.5	11	345	6000	20000	-22.2	31.06	132	0.1	1.54E-04	0.151866877
19-Feb-98	10	9.3	345	6000	20000	-30.2	9.2	242	3	3.51E-04	0.346137983
23-Feb-98	11.5	6.2	400	6000	20000	-24.3	75.949	287	0	9.47E-05	0.09344781
25-Feb-98	19	20.9	350	6000	5000	16.1	27.616	257	1	4.24E-04	0.418225400
28-Feb-98	6	11.4	400	6000	20000	-36.2	24.166	287	0.5	1.25E-04	0.123268513
9-Mar-98	-2	21.5	350	6000	20000	-26.4	62.13	212	2	9.44E-05	0.093092381
10-Mar-98	-3	12	350	6000	20000	-28.9	62.85	282	2	2.77E-04	0.273160024
11-Mar-98	-1	10.7	350	6000	20000	-28.2	80.549	292	1	1.02E-04	0.100587106
12-Mar-98	-3	10.4	350	6000	20000	-21.8	80.549	292	1	1.04E-04	0.102559402
2-Apr-98	17	10	400	6000	20000	-19	49.482	222	0	2.02E-05	0.019930053
6-Apr-98	18	15.2	400	6000	20000	-16.8	49.482	322	0	2.32E-05	0.022878636
14-Apr-98	21	11.1	400	6000	20000	-20.8	49.482	247	0	1.90E-05	0.018736814
16-Apr-98	12.5	21.2	350	6000	20000	-15.9	109.31	242	0	2.32E-05	0.022878636
19-Apr-98	15.5	4.6	400	6000	6000	3.2	11.507	267	0.5	0.0066384	6.546445547
22-Apr-98	14	8.2	400	6000	20000	-25.9	51.783	357	0	6.74E-05	0.066466382
24-Apr-98	20	15.7	350	6000	5000	16.1	26.46	322	0.1	5.33E-04	0.525616937
27-Apr-98	13	13.2	400	6000	20000	-20.1	21.864	347	0	4.81E-05	0.047433724

Cont'd Table 3

date	Ground level condition		aircraft condition			Jettison altitude			Results of jettison run		
	Mean Temp Celsius	Wind Speed mph	Speed mph	Fuel Jettisoned lbs	Altitude ft	Temp Celsius	wind speed mph	Direction degree	Ground fall (%) %	max deposition ml/m2	mg/m2
6-May-98	21	6.7	350	6000	20000	-13.7	62.13	275	0	7.99E-06	0.007879323
7-May-98	19	8.5	350	6000	20000	-12.1	78.25	275	0	1.42E-06	0.00140033
10-May-98	18	5.5	350	6000	20000	-13.7	37.97	287	0	1.35E-05	0.013312999
15-May-98	23	14.4	350	6000	20000	-12.2	89.75	212	0	2.14E-06	0.002110357
19-May-98	25.5	10.4	350	6000	20000	-13.3	26.46	272	0	5.21E-06	0.005138818
24-May-98	25	7.8	350	6000	20000	-14.9	33.37	222	0	1.37E-05	0.013489545
2-Jun-98	32.5	13.9	350	6000	20000	-7.6	31.66	267	0	2.13E-06	0.002100495
5-Jun-98	26.7	18.4	350	6000	20000	-11.5	87.45	277	0	3.23E-06	0.003188217
7-Jun-98	18.5	10.5	400	6000	20000	-14.3	42.577	282	0	1.22E-05	0.012042841
10-Jun-98	27.2	20	350	6000	20000	-10.9	26.46	247	0	3.11E-06	0.003068893
15-Jun-98	24	9.6	350	6000	20000	-16.3	26.46	247	0	8.32E-06	0.008206752
20-Jun-98	32	21.2	325	7000	20000	-8.9	28.76	267	0	2.98E-06	0.002938721
24-Jun-98	35	23.6	350	6000	20000	-8	11.507	202	0	3.87E-06	0.003816393
27-Jun-98	26.7	14.3	350	6000	20000	-4.6	4.6028	67	0	2.99E-06	0.002934731
1-Jul-98	28	12.8	350	6000	20000	-9.5	19.56	242	0	5.71E-05	0.056300057
3-Jul-98	30	12.7	300	7000	20000	-6.8	11.507	207	0	7.11E-06	0.007011513
7-Jul-98	33.6	11.7	250	7000	20000	-9.8	9.205	212	0.5	9.41E-06	0.009279634
10-Jul-98	32.5	13.3	400	5000	20000	-5.9	13.808	207	0	7.07E-06	0.006972067
15-Jul-98	26.5	7.1	375	5000	20000	-8.5	11.507	52	0	4.21E-06	0.004151684
18-Jul-98	**30.5**	**8.1**	**400**	**6000**	**20000**	**-8.3**	**9.2059**	**97**	**0**	**1.76E-05**	**0.017356207**
22-Jul-98	31.1	11.3	400	6000	20000	-8.3	9.2059	272	0	5.56E-06	0.005482983
26-Jul-98	43.4	14.2	350	6000	20000	-7.7	16.102	277	0	3.87E-06	0.003816393
3-Aug-98	31.5	6.8	350	6000	20000	-8.2	18.411	242	0	4.14E-06	0.004082652
4-Aug-98	27	7	400	6000	20000	-8.2	28.769	242	0	1.74E-05	0.0171767
5-Aug-98	25.5	6.9	400	6000	20000	-7.6	28.769	247		1.34E-05	0.013214385
12-Aug-98	27	0	345	5000	20000	-8.6	11.507	307	0	2.16E-05	0.021300799
17-Aug-98	30	10	345	5000	20000	-8.8	9.2	72	0	6.67E-06	0.006577608
19-Aug-98	31	5.8	345	5000	20000	-8	13.8	137	0	6.91E-06	0.006814283
24-Aug-98	30	9.8	345	5000	20000	-4.4	9.2	77	0	5.33E-06	0.005256169
26-Aug-98	32	8.2	345	5000	20000	-5.6	9.2	157	0	5.66E-06	0.005584162
31-Aug-98	31.5	6.3	350	6000	20000	-8.9	11.507	352	0	1.11E-05	0.010946244
3-Sep-98	32	7	400	6000	20000	-6.4	16.11	357	0	5.76E-06	0.005680213
4-Sep-98	32	5.3	400	6000	20000	-6.2	16.11	322	0	4.27E-06	0.004210852
6-Sep-98	31.5	11.9	400	6000	20000	-7.4	11.507	52	0	5.90E-06	0.005818274
10-Sep-98	24.5	6.3	400	6000	20000	-8.2	6.9044	142	0	7.19E-06	0.007091377
14-Sep-98	26	7.6	400	6000	20000	-6.9	11.507	262	0	6.45E-06	0.006360655
25-Sep-98	28	14.7	400	6000	20000	-8.7	18.412	257	0	4.33E-06	0.004267063
4-Oct-98	24.5	14.7	400	6000	20000	12.9	28.769	197	0	4.54E-06	0.004477112
8-Oct-98	16.5	4.9	400	6000	20000	-10	33.371	312	0	1.30E-05	0.012819925
12-Oct-98	19.5	6.8	400	6000	6000	11.6	9.2059	27	0.2	7.48E-04	0.737638779
19-Oct-98	**15**	**6.3**	**400**	**6000**	**6000**	**9.1**	**18.412**	**322**	**0.1**	**9.09E-04**	**0.896408623**
22-Oct-98	12	6.1	400	6000	6000	7.4	16.11	27	0	9.32E-04	0.919600028
26-Oct-98	19	11.7	400	6000	20000	14.8	19.563	197	0	2.86E-04	0.282432816
28-Oct-98	21	13.1	400	6000	20000	-11.2	59.839	232	0	5.57E-06	0.005492845
31-Oct-98	20.5	8.7	400	6000	6000	12.2	21.864	182	0	2.73E-04	0.269218431
6-Nov-98	6	6.3	400	6000	6000	1.3	13.809	197	3	3.08E-03	3.033292943
8-Nov-98	9	6.3	400	6000	6000	8	18.417	242	1.5	1.66E-03	1.635230779
11-Nov-98	9.5	10.6	400	6000	6000	1.6	19.563	242	1.5	1.48E-03	1.461781677
18-Nov-98	17.5	16.2	400	6000	6000	14.2	47.18	232	0.5	2.99E-04	0.294858282
27-Nov-98	**15**	**11.7**	**400**	**6000**	**6000**	**13.2**	**18.412**	**232**	**0.1**	**4.42E-04**	**0.43587746**
29-Nov-98	19	17.8	400	6000	6000	16.9	40.276	212	0.1	2.33E-04	0.279772507
2-Dec-98	12	14.3	350	6000	20000	-9.7	37.37	232	0	2.85E-06	0.002810522
3-Dec-98	18	14.4	345	6000	20000	-10.7	33.37	212	0	6.38E-06	0.006291625
6-Dec-98	12.5	14.8	345	6000	20000	-13.1	19.56	231	0	9.12E-06	0.008993678
15-Dec-98	9	8.9	350	6000	20000	-17.9	19.56	42	0	1.05E-04	0.103052478
18-Dec-98	9	18.9	350	5000	20000	-12.7	59.83	232	0.1	1.09E-05	0.010669707
21-Dec-98	-3.5	16	345	6000	20000	-15.1	82.85	242	0	2.66E-05	0.026231339
23-Dec-98	-7	9.2	345	6000	20000	-16.7	96.35	237	0.1	6.33E-05	0.06239359
31-Dec-98				6000	6000	5.6	13.809	327	0	1.09E-03	1.070365148
4-Jan-99	-4.3	3.2	400	6000	20000	-36.5	59.839	282	1.5	3.29E-04	0.324442725
8-Jan-99	-4	12.5	400	7000	20000	-20.7	57.535	232	1	5.43E-05	0.053547842
9-Jan-99	-6.3	13.9	400	6000	20000	-26.4	40.276	282	0.5	1.29E-04	0.127213105
15-Jan-99	9	16.6	350	6000	20000	-17.1	37.97	257	0	4.05E-05	0.039938998
19-Jan-99	11	14.6	400	6000	20000	-19.6	64.441	237		1.69E-05	0.016616595
20-Jan-99	11.5	9	250	7000	20000	-13.9	49.48	262	2	3.42E-04	0.33726265
26-Jan-99	11	13.3	300	7000	20000	-11.3	62.13	217	0	1.11E-05	0.010946244
1-Feb-99	9	10.6	250	7000	20000	-15.6	44.87	242	2	3.42E-04	0.33726265
6-Feb-99	16	12.9	300	7000	20000	-14.3	71.3434	243	0	1.51E-05	0.014890836
13-Feb-99	7	7.1	350	6000	20000	-14.3	26.46	212	0	1.27E-04	0.125240809
15-Feb-99	**13**	**20.7**	**300**	**7000**	**20000**	**-14.3**	**45.57**	**252**	**0**	**6.17E-05**	**0.060845338**
21-Feb-99	3	12.2	400	7000	20000	-15.3	94.35	302	1	7.18E-05	0.070828396
22-Feb-99	7	10.6	400	7000	20000	-29.1	58.68	292	3	9.12E-05	0.089936707
1-Mar-99	0.5	11.5	600	6000	20000	-26.8	48.32	262	0	5.04E-05	0.049701864
5-Mar-99	16.5	19.9	400	6000	20000	-33	58.66	257	0	2.69E-05	0.026527384
13-Mar-99	**2**	**15.5**	**400**	**7000**	**20000**	**-23.5**	**64.43**	**200**	**2**	**1.60E-04**	**0.157783696**
23-Mar-99	13	16	400	6000	20000	-17.1	42.67	262	0.1	6.33E-05	0.062373867
28-Mar-99	9	20.4	400	6000	20000	-24.5	35.67	222	0	3.51E-05	0.034633521
1-Apr-99	19	20.3	400	6000	20000	-18.4	33.371	212	0	8.77E-06	0.008648519
6-Apr-99	15.5	8.7	400	6000	20000	-16.9	40.276	257	0	3.51E-05	0.034643383
15-Apr-99	11	28.5	400	6000	20000	-22.2	13.809	37	0	8.63E-05	0.085104581
24-Apr-99	10.5	14.4	400	6000	20000	-13.2	42.577	327	0	2.03E-05	0.019994153
27-Apr-99	17	7.3	400	6000	20000	-24.2	44.875	242	0	4.81E-05	0.047468239
29-Apr-99	15.3	11.2	400	6000	20000	-14.9	18.412	237	0	1.43E-04	0.141019178
1-May-99	**16.5**	**9.4**	**400**	**6000**	**20000**	**-14.4**	**24.166**	**147**	**0**	**5.76E-05**	**0.056802131**
4-May-99	20.5	20.7	400	6000	20000	-16.4	59.839	212	0	1.21E-05	0.011932792
9-May-99	22	14.2	400	6000	20000	-15	19.563	272	0	5.68E-06	0.005601321
14-May-99	21	11.9	400	6000	20000	-14	24.166	237	0	9.82E-06	0.009683974
18-May-99	16.5	6.4	400	6000	20000	-15.1	64.441	262	0	1.87E-05	0.018440669
23-May-99	23	10.7	400	6000	20000	-11.4	42.577	237	0	1.04E-05	0.010276356
1-Jun-99	25	11.6	400	6000	20000	-13.8	44.879	247	0	2.74E-06	0.002700073
4-Jun-99	26	14.3	400	6000	20000	-12.5	34.07	227	0	3.35E-06	0.003303596
7-Jun-99	25	9.3	400	6000	20000	-11.5	9.2059	152	0	8.28E-06	0.008165306
16-Jun-99	21.5	9.3	400	6000	20000	-11.5	28.769	292	0	9.13E-06	0.009003532
20-Jun-99	24	7	400	6000	20000	-9.3	6.9044	82	0	1.17E-05	0.011557656
22-Jun-99	22.5	7.1	400	6000	20000	10.6	16.11	202	0	7.56E-06	0.00745528
26-Jun-99	26	7.8	400	6000	20000	9.1	19.563	322	0	7.02E-06	0.006922276
2-Jul-99	28	13.5	400	6000	20000	-6.3	4.603	212	0	3.48E-06	0.003431795
7-Jul-99	29	4.8	400	6000	20000	-8.3	6.9044	112	0	1.19E-05	0.011735162
14-Jul-99	27	10.9	400	6000	20000	-8.8	4.603	317	0	7.70E-06	0.00759334
18-Jul-99	27.5	9.4	400	6000	20000	-7.3	11.507	167	0	7.14E-06	0.007041097
26-Jul-99	27.5	10	400	6000	20000	-6.7	11.507	112	0	5.85E-06	0.005768966
28-Jul-99	29.5	9.4	400	6000	20000	-8	13.809	122	0	5.13E-06	0.00505894
31-Jul-99	31	12	400	6000	20000	-11.7	28.769	292	0	1.22E-05	0.012031007

Cont'd Table 3

Date	Ground level condition: Mean Temp Celsius	Ground level condition: Wind Speed mph	Aircraft condition: Speed mph	Aircraft condition: Fuel Jettisoned lbs	Aircraft condition: Altitude ft	Jettison altitude: Temp Celsius	Jettison altitude: wind speed mph	Jettison altitude: Direction degree	Results of jettison run: Ground fall (%) %	Results of jettison run: max deposition ml/m2	mg/m2
1-Aug-99	31	9.6	400	6000	20000	-8.5	26.467	177	0	4.37E-06	0.004309467
3-Aug-99	29	7.4	400	6000	20000	-8.3	9.2059	187	0	9.58E-06	0.009447299
8-Aug-99	31	8.7	400	6000	20000	-6.1	13.809	277	0	4.97E-06	0.004901156
14-Aug-99	26	9	400	6000	20000	-5.5	19.563	357	0	1.52E-05	0.014990451
20-Aug-99	26	7.5	400	6000	20000	7.1	17.809	27	0	6.31E-06	0.006222595
24-Aug-99	29	7	400	6000	20000	7.7	44.879	327	0	4.12E-06	0.00406293
1-Sep-99	28.5	10	400	6000	20000	-8.3	11.507	82	0	7.08E-06	0.006980462
3-Sep-99	28	9.1	400	6000	20000	7.5	6.9044	307	0	1.20E-05	0.011831777
6-Sep-99	24	12.9	400	6000	20000	-9.5	33.371	202	0	6.97E-06	0.006871452
14-Sep-99	21.5	8.5	400	6000	20000	-13.9	24.166	242	0	3.51E-05	0.034611798
21-Sep-99	14.5	13.6	400	6000	20000	-12.8	44.879	281	0	2.32E-05	0.022876636
25-Sep-99	19.5	7.5	400	6000	20000	-12.4	24.166	277	0	1.04E-05	0.010256633
27-Sep-99	22.5	11.9	400	6000	20000	-9.4	33.371	227	0	1.90E-06	0.001845578
5-Oct-99	16.5	4.5	400	6000	20000	-10.1	56.11	267	0	1.92E-05	0.018934044
10-Oct-99	22	2.9	400	6000	20000	-9.6	31.07	22	0	1.19E-05	0.011735162
17-Oct-99	13	19.3	400	6000	20000	-15.1	37.974	242	0	4.26E-05	0.042009909
25-Oct-99	18	11.2	400	6000	20000	-13.4	14.907	317	0	7.83E-06	0.00772154
29-Oct-99	20.5	18.9	400	6000	20000	-17.9	19.563	251	0	1.52E-05	0.014989451
31-Oct-99	13.5	12.3	400	6000	20000	-20.3	51.783	68	0	4.70E-05	0.046346961
2-Nov-99	9.5	17.8	400	6000	16000	-12.4	58.688	297	0	7.27E-05	0.071692967
5-Nov-99	18	16.3	400	6000	20000	-12.5	9.2059	227	0	6.58E-06	0.006488854
10-Nov-99	18.5	10	400	6000	20000	-12.9	28.769	262	0	9.97E-06	0.009792431
14-Nov-99	19	8.1	400	6000	20000	-11.9	9.2059	227	0	1.74E-05	0.017316207
20-Nov-99	11	8.1	400	6000	20000	-15.2	24.166	342	0	6.74E-05	0.066489344
22-Nov-99	17.5	9.3	400	6000	20000	-17.8	58.688	217	0	1.94E-05	0.019092058
24-Nov-99	5	7.6	400	6000	20000	-17.8	71.346	227	0	2.77E-05	0.027316392
26-Nov-99	16	11	400	6000	20000	20.3	54.085	322	0	4.64E-05	0.045461427
28-Nov-99	10	8.9	400	6000	20000	16.8	44.879	237	0	3.34E-05	0.032641502
3-Dec-99	16	21.2	400	6000	20000	19.7	28.769	203	0	8.93E-06	0.00878458
4-Dec-99	12.5	11.6	400	6000	20000	-18.4	58.688	192	0	3.21E-05	0.031655354
10-Dec-99	5	9.5	400	6000	20000	-18.5	59.839	164	0	4.41E-05	0.043489131
14-Dec-99	6.5	16.6	400	6000	20000	-21.1	69.044	217	0	6.58E-05	0.064865163
20-Dec-99	6.5	12.9	400	6000	20000	-27.1	51.783	237	0.5	2.52E-04	0.248509321
30-Dec-99	4.5	15	400	6000	20000	-16.5	59.839	257	0	1.42E-05	0.014023026
31-Dec-99	4.5	8.1	400	6000	20000	-20.5	19.563	257	0	7.58E-05	0.074750026
5-Jan-00			400	6000	5000	9.8	16.11	237	3	0.00155181	1.53651735
10-Jan-00	9	10.1	400	6000	20000	-15.31	116.22	182	0	4.49E-05	0.04413866
14-Jan-00				6000		-25.5	96.662	287		2.97E-04	0.292985906
16-Jan-00	13.5	10.6	400	6000	20000	-15.3	35.673	267	0	4.02E-06	0.003790898
23-Jan-00	1.5	9.2	400	5000	20000	-21.9	66.743	262	0	5.93E-05	0.058478182
25-Jan-00	0.5	13	400	6000	20000	-19.2	71.346	322	0	4.63E-05	0.045629073
26-Jan-00	-1.5	8.3	400	6000	20000	-8.9	9.2059	322	0	7.07E-05	0.069720678
28-Jan-00	-4.5	7.6	400	6000	5000	28.8	33.371	267	1	4.47E-04	0.441104845
1-Feb-00	9	8.7	400	6000	20000	-25.8	44.879	277	0	1.93E-04	0.190326183
6-Feb-00	7.5	13.9	400	6000	20000	25.8	42.577	272	0	1.26E-04	0.124254661
17-Feb-00	10.5	9.7	400	6000	20000	-19.3	47.18	247	0	3.79E-05	0.037375642
22-Feb-00	15.5	10.8	400	6000	20000	27.9	44.879	237	0	3.49E-05	0.034416965
25-Feb-00	16.5	22.4	400	6000	20000	-10.6	54.085	317	0	9.11E-06	0.008983609
27-Feb-00	12.5	7	400	6000	20000	-27.4	56.386	312	0	9.82E-05	0.096839741
28-Feb-00	14.5	16	400	6000	20000	-27.4	47.18	297	0	1.09E-04	0.107490143
1-Mar-00	11.5	10.7	400	6000	20000	-18.7	44.879	277	0	1.13E-05	0.011031236
3-Mar-00	6.5	11.9	400	6000	20000	-22.7	92.059	262	0	6.56E-05	0.064691915
5-Mar-00	13	12	400	6000	20000	-16.6	26.467	227	0	5.23E-05	0.051575546
20-Mar-00	13.5	12.7	400	6000	20000	-19.6	62.577	257	0	4.55E-05	0.044869739
21-Mar-00	16	13.5	400	6000	20000	-17.3	73.647	187	0	1.67E-05	0.016419366
24-Mar-00	17	13.2	400	6000	20000	-14.5	54.085	247	0	2.40E-05	0.023667554
28-Mar-00	17.5	12.2	400	6000	20000	-18.1	59.839	312	0	2.36E-05	0.023271095
8-Apr-00	8	16.6	400	6000	20000	-18.1	89.258	302	0	4.25E-05	0.041911294
11-Apr-00	16	12.1	400	6000	20000	-18.7	24.166	262	0	1.74E-05	0.017191423
13-Apr-00	12	5.9	400	6000	10000	-19.3	34.07	252	0	7.64E-05	0.075341715
15-Apr-00	16.5	17.8	400	6000	10000	-18.2	19.563	252	0	3.01E-06	0.002968306
18-Apr-00	21	12.4	400	6000	20000	-14.1	31.07	277	0	1.15E-05	0.011291796
23-Apr-00	18.5	13.2	400	6000	20000	31.2	73.647	227	0	8.02E-04	0.791876124
27-Apr-00			400	6000	20000	31.2	73.647	127	0	1.65E-05	0.016271444
2-May-00	26	21.5	400	6000	20000	12.8	16.11	262	0	2.26E-06	0.002228695
12-May-00	24.5	16.2	400	6000	20000	-10.8	44.879	222	0	2.33E-06	0.002297125
21-May-00	22.5	8.2	400	6000	20000	-15.5	28.769	277	0	2.10E-05	0.020709911
22-May-00	26.5	10.9	400	6000	20000	-15.8	35.673	292	0	6.47E-06	0.006380378
28-May-00	21	7.1	400	6000	20000	-12.9	47.18	317	0	5.50E-06	0.005423815
1-Jun-00	27	12	400	6000	20000	-9	16.11	167	0	4.81E-06	0.004740414
13-Jun-00	22.5	8.9	400	6000	20000	-6.1	28.769	312	0	1.25E-05	0.012177544
14-Jun-00	18.5	6.8	400	6000	20000	-9.9	31.07	287	0	1.25E-05	0.012326851
20-Jun-00	23.5	7.8	400	6000	20000	-9.7	24.166	267	0	3.76E-06	0.003707917
25-Jun-00	26	8.6	400	6000	20000	-11.2	6.9044	207	0	5.62E-06	0.005542112
1-Jul-00	26.5	11.2	400	6000	10000	-9	13.809	297	0	9.64E-06	0.009506448
7-Jul-00	27	8.4	400	6000	10000	-4.7	9.2059	77	0	1.53E-05	0.015107749
11-Jul-00	28.5	10.5	400	6000	20000	-6.4	13.809	227	0	1.78E-04	0.175534362
20-Jul-00	28.5	12	400	6000	20000	-8.2	16.11	167	0	4.89E-06	0.00481832
22-Jul-00	22.5	16.8	400	6000	20000	-11.8	33.371	21	0	6.16E-06	0.006011519
25-Jul-00	24.5	9.7	400	6000	20000	-8.2	47.18	142	0	7.76E-06	0.007652509
4-Aug-00	30	11	400	6000	20000	-8.3	24.166	7	0	9.89E-06	0.009753005
8-Aug-00	30.5	12.3	400	6000	5000	23.3	33.371	217	0.2	1.62E-04	0.159755992
11-Aug-00	31	6.3	400	6000	20000	-8.4	4.603	347	0	9.26E-06	0.009131731
14-Aug-00	27.5	9.4	400	6000	20000	-6.7	24.166	227	0	7.35E-06	0.007248169
18-Aug-00	29	9	400	6000	20000	-7.3	16.11	257	0	5.12E-06	0.005246306
21-Aug-00	29.5	11.5	400	6000	20000	-6.2	16.11	312	0	4.59E-06	0.00452602
1-Sep-00	33	6.8	400	6000	20000	-6.2	16.11	297	0	4.56E-06	0.004496835
6-Sep-00	27	7.5	400	6000	20000	-6.5	13.809	7	0	8.36E-06	0.008244158
13-Sep-00	28	6.8	400	6000	20000	-6.5	13.809	357	0	1.07E-05	0.010532002
17-Sep-00	23	8.4	400	6000	20000	-9.1	19.563	352	0	6.76E-06	0.006666364
26-Sep-00	14.5	14.3	400	6000	20000	-7.1	44.879	247	0	6.68E-06	0.006577460
1-Oct-00	21.5	14.6	400	6000	20000	-3.1	28.769	277	0	8.87E-06	0.008747114
10-Oct-00	9	10.2	400	6000	20000	-17.5	18.412	267	0	1.27E-04	0.125240609
11-Oct-00	16	12.5	400	6000	20000	-11.5	26.467	277	0	2.22E-05	0.021842118
13-Oct-00	21.5	13.3	400	6000	20000	-11.5	28.769	222	0	2.64E-05	0.026034131
16-Oct-00	19.5	7.6	400	6000	5000	13	16.11	142	0.1	6.81E-04	0.67271012
24-Oct-00	20.5	9.6	400	6000	20000	-12.5	19.563	182	0	1.12E-05	0.011044859
27-Oct-00	20.5	4.5	400	6000	20000	-14.4	18.412	222	0	1.40E-05	0.013820866
29-Oct-00	19.5	13.6	400	6000	20000	-13.3	47.18	187	0	7.73E-06	0.007622925
30-Oct-00	20	9.4	400	6000	20000	-12.8	35.673	357	0	3.41E-06	0.003362765
3-Nov-00	19.5	15.2	400	6000	20000	-12.8	69.044	202	0	1.81E-06	0.001784928
5-Nov-00	14	9.1	400	6000	20000	-13.4	26.467	247	0	1.81E-06	0.001784928
9-Nov-00	2.5	11.6	400	6000	20000	-19.7	59.839	277	0	5.24E-04	0.516741684
13-Nov-00	1	10	400	6000	20000	-20	125.43	232	0.01	4.98E-05	0.049110175
16-Nov-00	1	14	400	6000	20000	28.5	109.32	247	0.01	5.88E-05	0.057926201
21-Nov-00	5.5	8.9	400	6000	20000	-23.2	59.839	312	0.1	1.28E-04	0.126226937
23-Nov-00	10	7.7	400	6000	20000	-20.6	51.783	252	0.01	4.96E-05	0.048912046
25-Nov-00	7	10.1	400	6000	20000	21.8	18.412	312	0	7.42E-05	0.073172189
1-Dec-00	7	12.9	400	6000	20000	-17	69.044	252	0	1.77E-05	0.017464663
11-Dec-00	-10.5	8.1	400	6000	20000	-17.1	73.647	252	0.02	7.15E-05	0.070509530
17-Dec-00	-5	8.7	400	6000	5000	-8.9	56.386	322	5	3.00E-03	2.961427
19-Dec-00	2.5	18.8	400	6000	20000	-16.2	62.14	262	0.1	1.97E-05	0.01915008
23-Dec-00	-2.5	11.5	400	6000	20000	-26.7	56.386	297	0.1	1.34E-04	0.131880001
25-Dec-00	-5	9.7	400	6000	20000	-12.9	54.085	142	0	9.08E-05	0.089552100
29-Dec-00	-1	9.7	400	6000	20000	-22.6	51.783	282	0	8.12E-05	0.080071226

[illegible]

Date	Ground level conditions		Aircraft conditions			At release altitude			[illegible]		
	Mean Temp Celsius	Wind Speed mph	Speed mph	Fuel [illegible] lbs	Altitude ft	Temp Celsius	Wind speed mph	Direction degrees	[illegible] (%)	[illegible] deposition	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

APPENDIX H

FJSIM SIMULATIONS

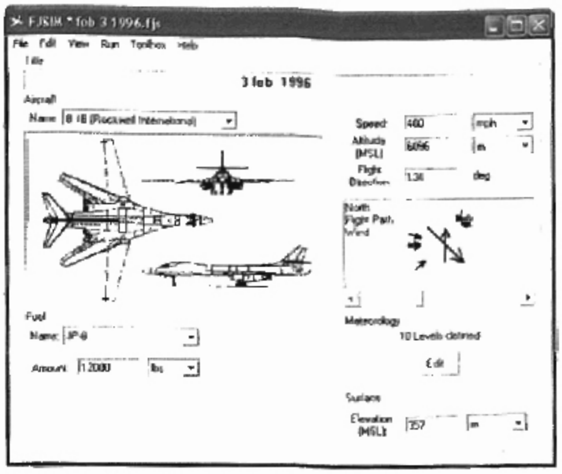


Figure 1: Input Values for B-1B Lancer on February 3, 1996

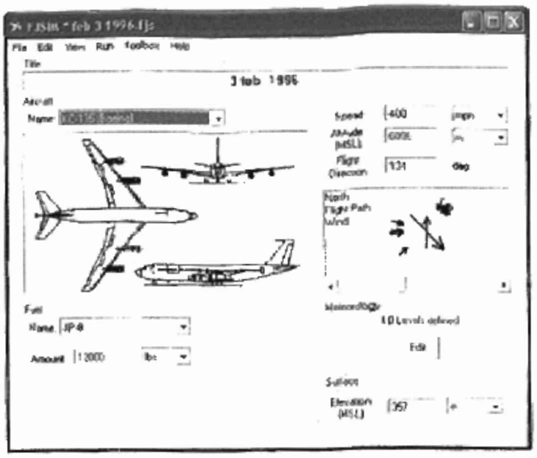


Figure 2: Input Values for the KC-135 on February 3, 1996

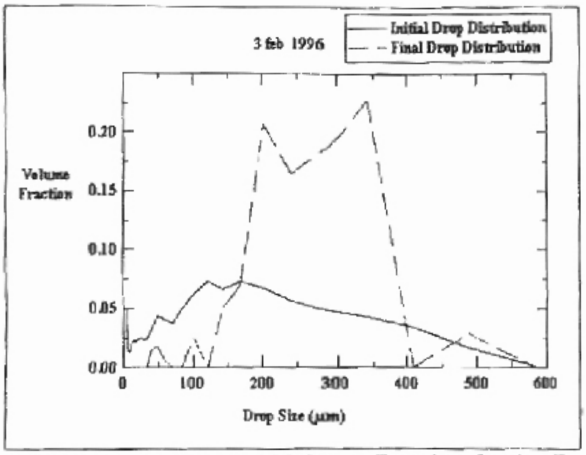


Figure 3(a): Incremental Volume Fraction for B-1B

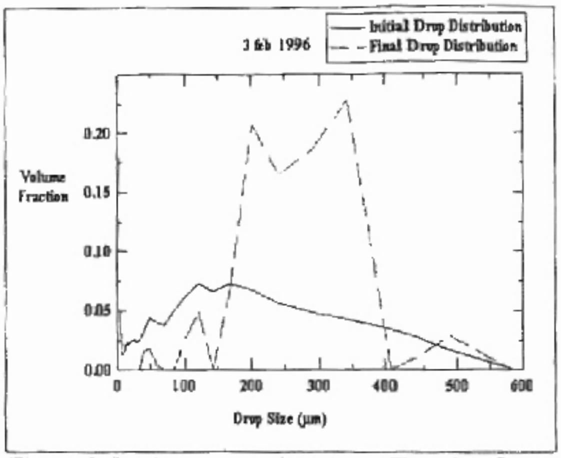


Figure 3 (b): Incremental Volume Fraction for KC-135

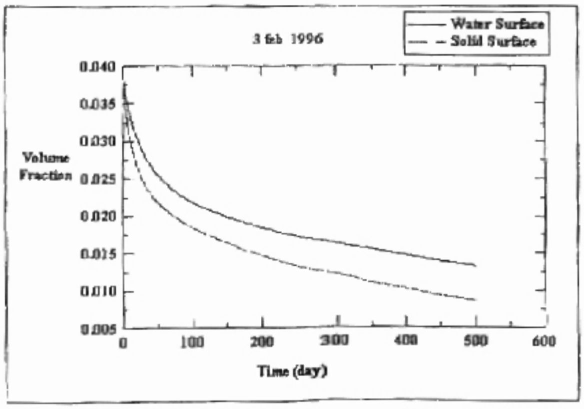


Figure 4(a): Surface evaporation for the B-1B

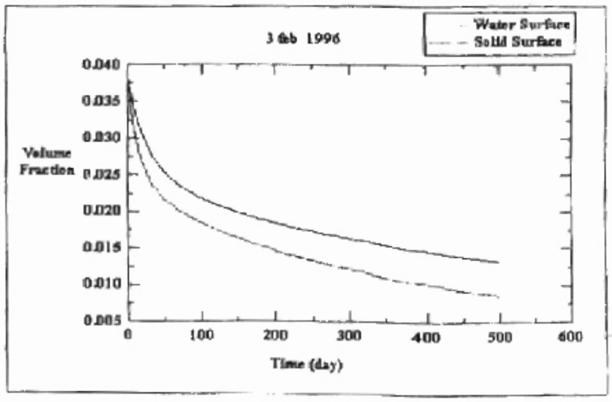


Figure 4(b): Surface evaporation for the KC-135

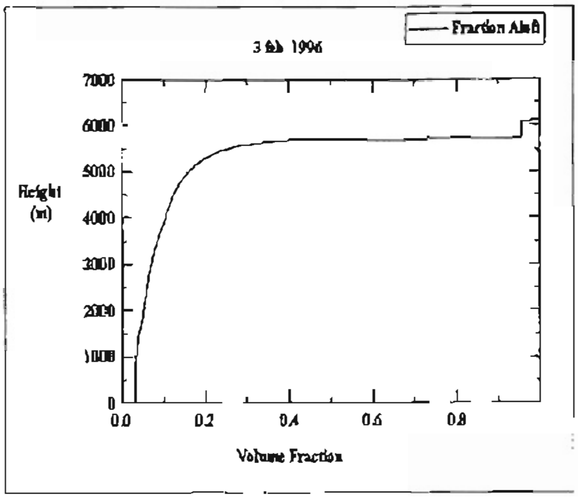


Figure 5: Plot of volume fraction aloft with height for the KC-135

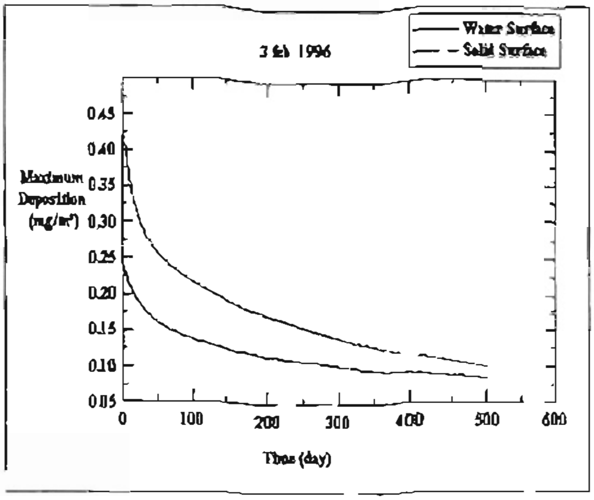


Figure 6: Maximum deposition time history plot for the KC-135

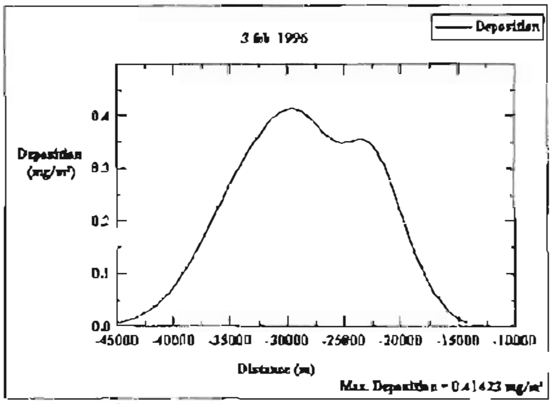


Figure 7(a) : Deposition cross section for the B-1B

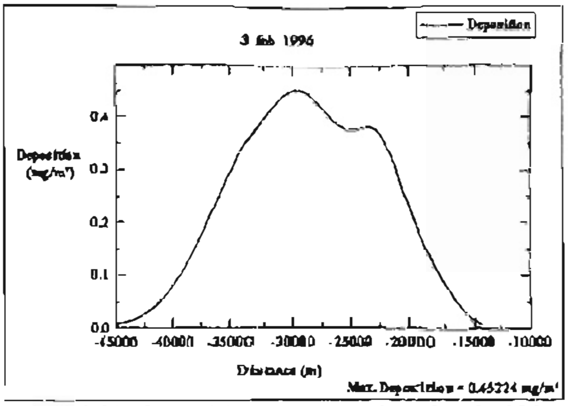


Figure 7(b) :Deposition cross section for the KC-135

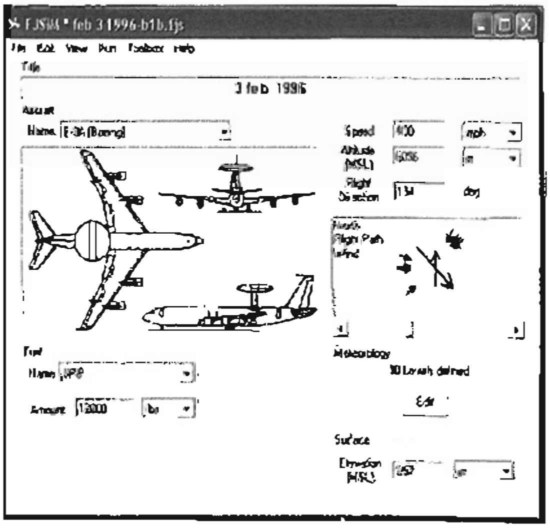


Figure 8(a): Input Values for E3A when the amount of fuel is 12,000 lbs on February 3, 1996

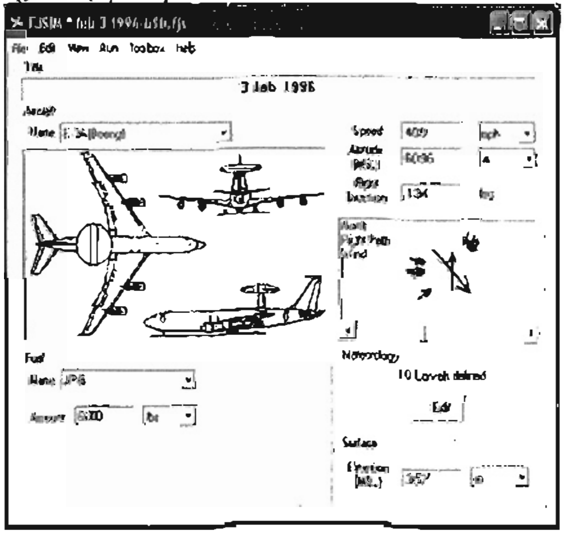


Figure 8(a): Input Values for E3A when the amount of fuel is 6,000 lbs

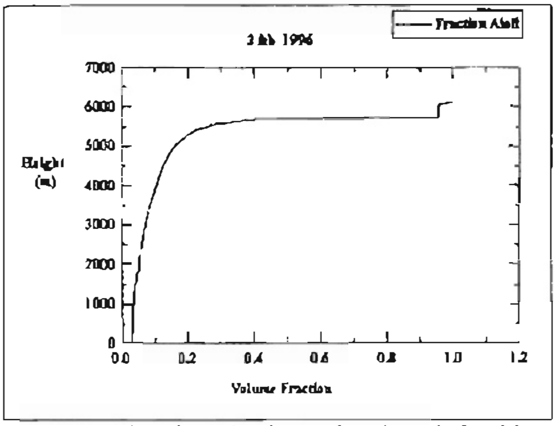


Figure 9 (a): Plot of volume fraction aloft with height for E-3A when the amount of fuel is 12,000 lbs

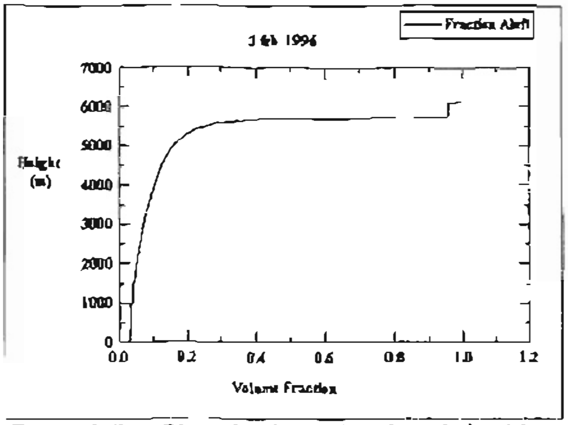


Figure 9 (b): Plot of volume fraction aloft with height for E-3A when the amount of fuel is 6,000 lbs

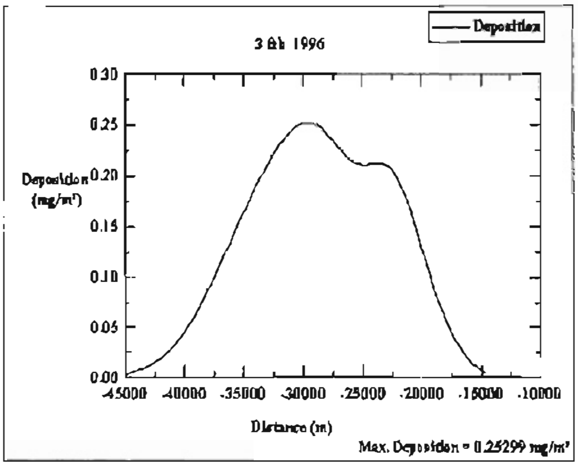


Figure 10: Deposition cross section for the E-3A

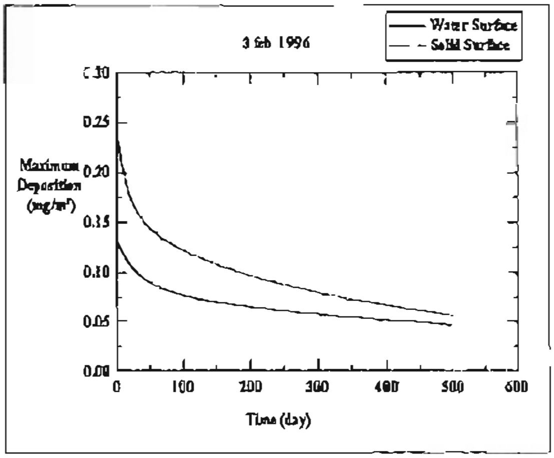


Figure 11: Maximum deposition time history plot for E-3A

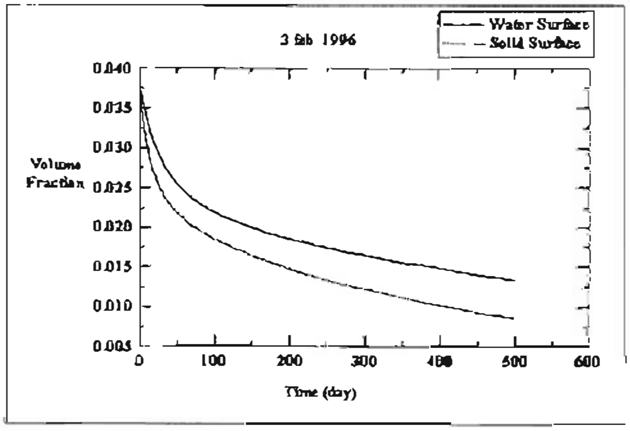


Figure 12: Surface evaporation for E-3A

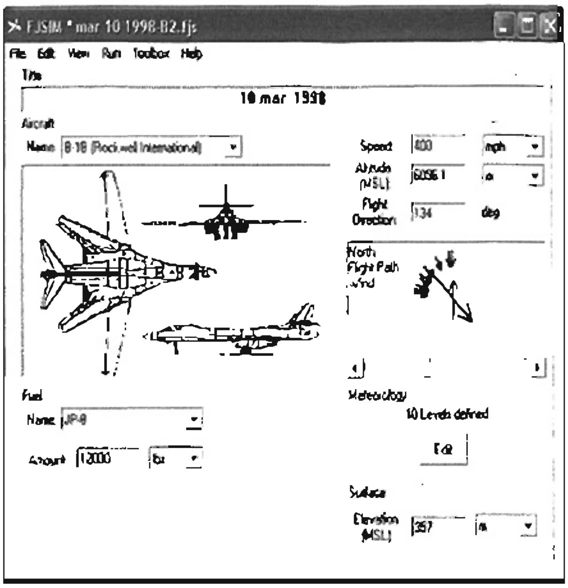


Figure 13(a) Input Values for B-1B lancer on March 10, 1998

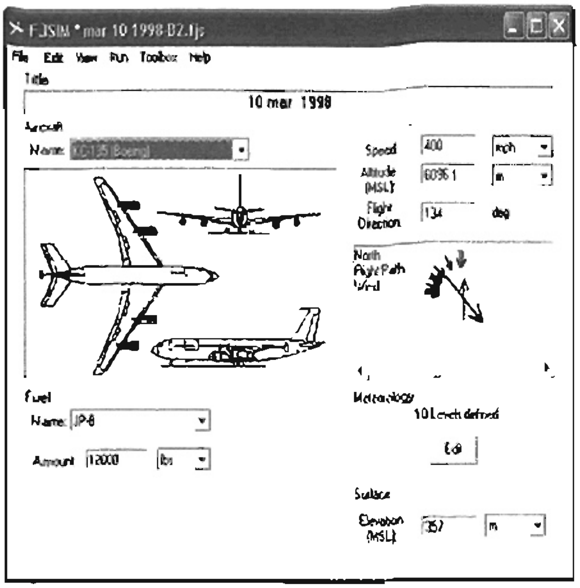


Figure 13 (b): Input Values for KC-135 on March 10, 1998

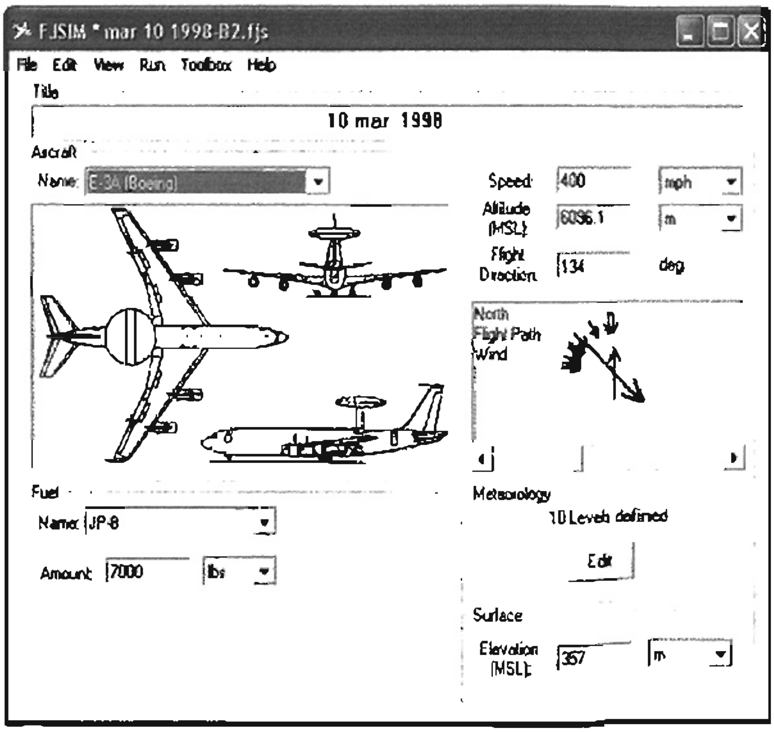


Figure 13 (c): Input Values for E-3A on March 10, 1998

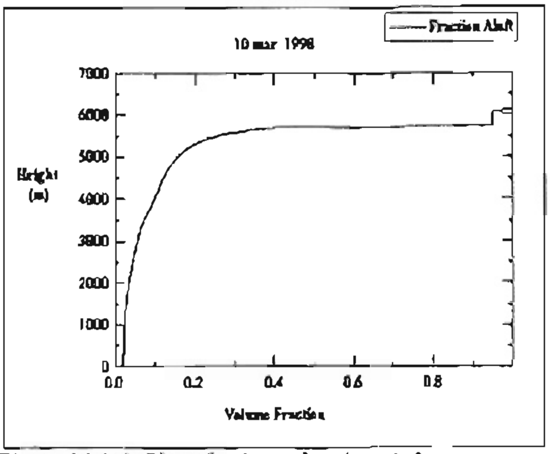


Figure 14 (a): Plot of volume fraction aloft
with height for E-3A

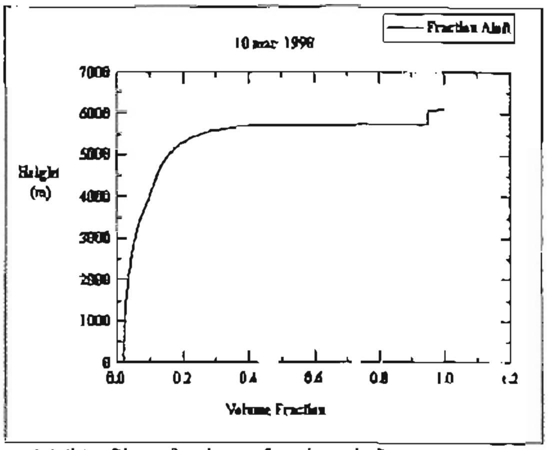


Figure 14 (b) : Plot of volume fraction aloft
with height for KC-135

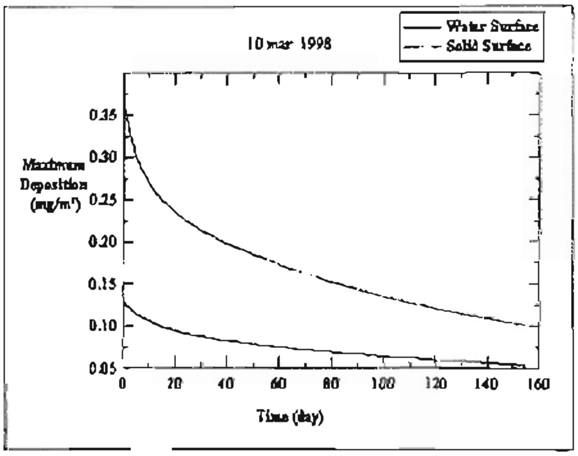


Figure 15 (a): Maximum deposition time
history plot for B-1B

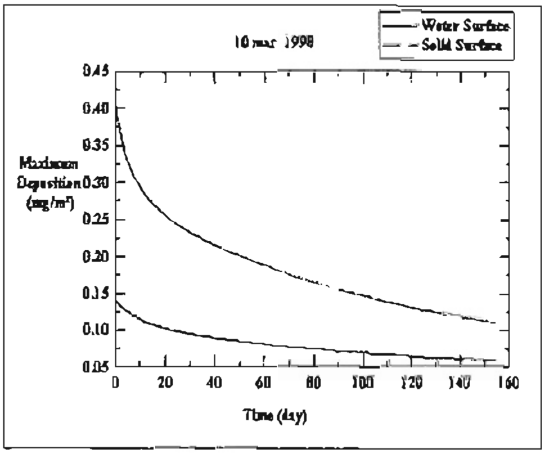


Figure 15 (b): Maximum deposition time history
plot for KC-135

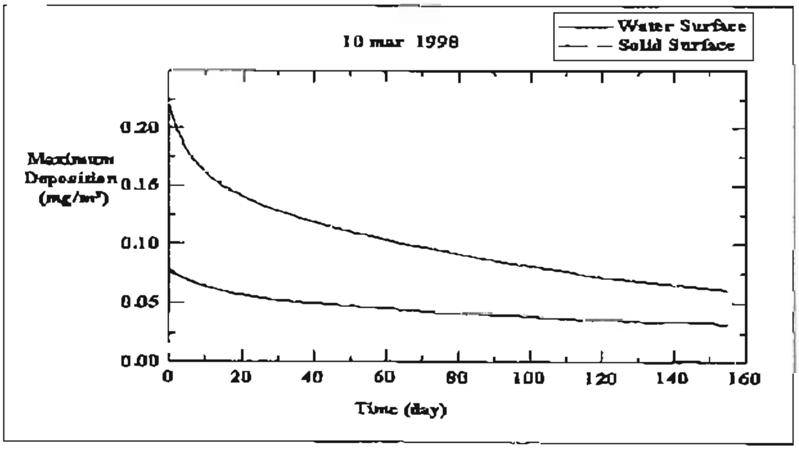


Figure 15 (c): Maximum deposition time history plot for E-3A

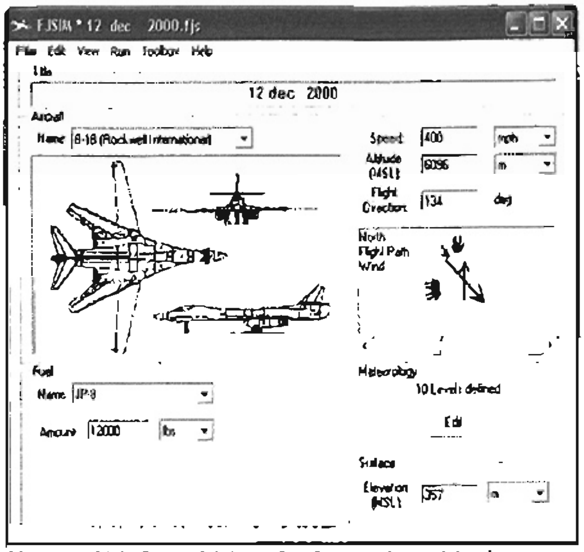


Figure 16(a): Input Values for B-1B when altitude is 20,000 feet AGL

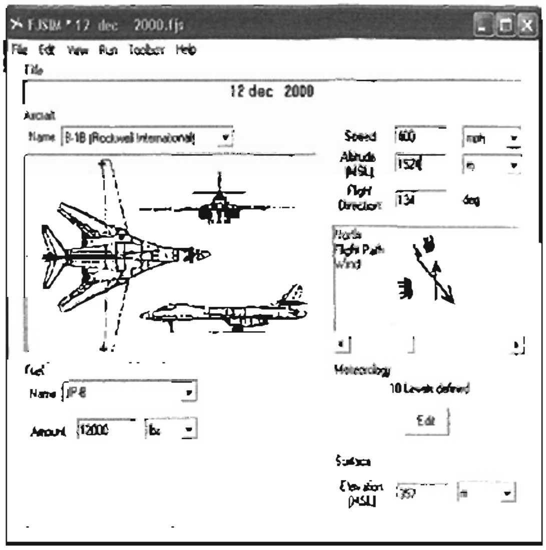


Figure 16(b): Input Values for B-1B when altitude is 5,000 feet AGL

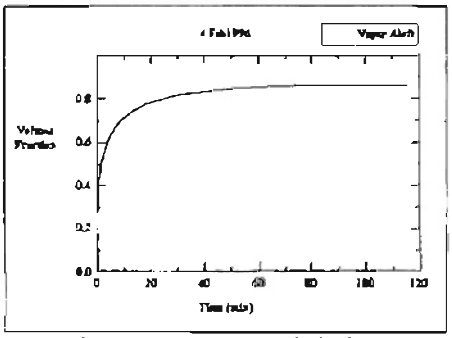


Figure 16 (c): Vapor aloft plot.

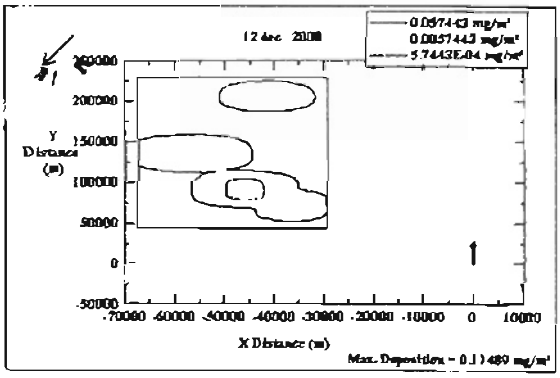


Figure 17 (a): Isopleth deposition plot when the fuel was jettisoned from 20,000 feet AGL

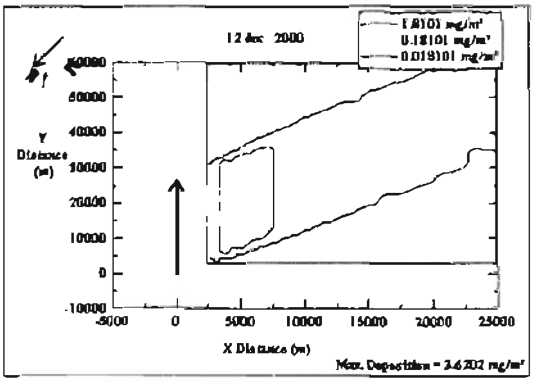


Figure 17 (b): Isopleth deposition plot when the fuel was jettisoned from 5,000 feet AGL

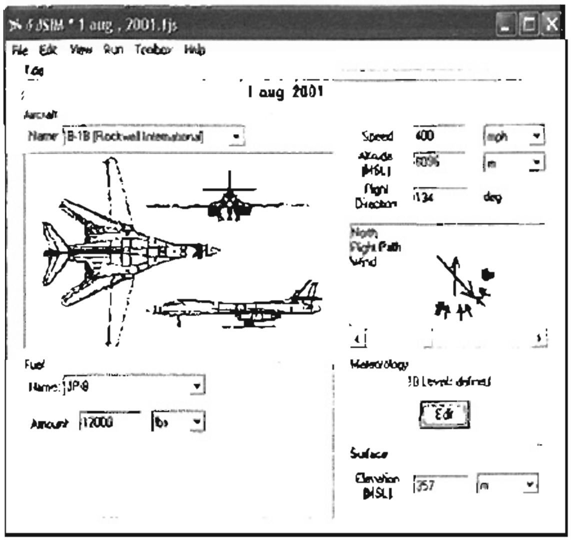
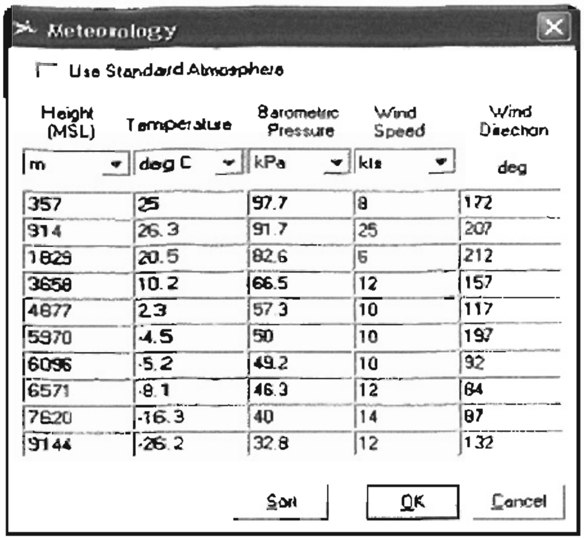
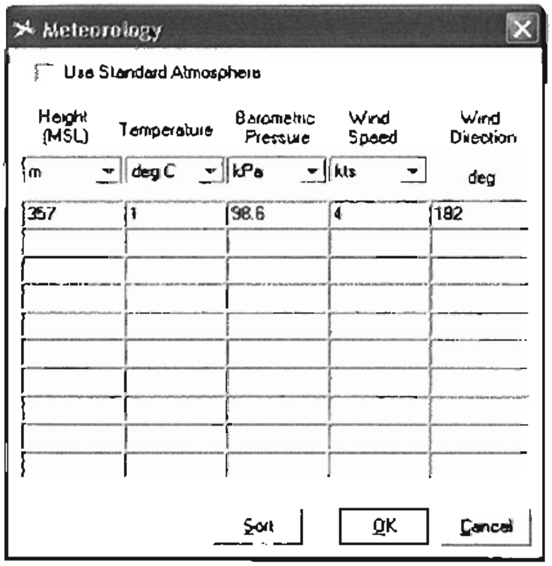


Figure 18: Input values for B-1B

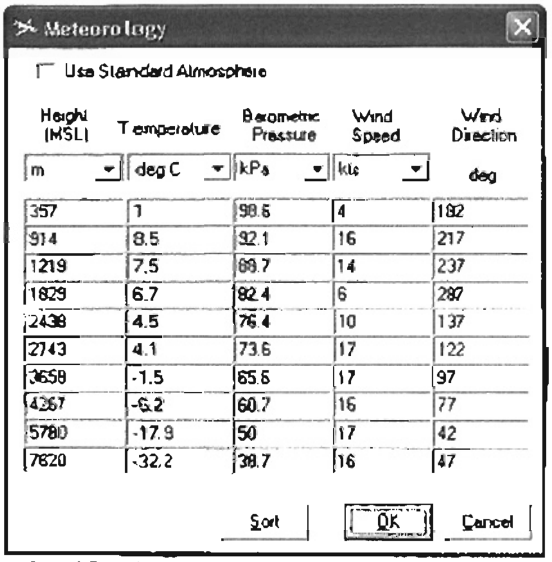


Height (MSL)	Temperature	Barometric Pressure	Wind Speed	Wind Direction
m	deg C	kPa	kts	deg
357	25	97.7	8	172
914	26.3	91.7	25	207
1829	20.5	82.6	6	212
3658	10.2	66.5	12	157
4877	2.3	57.3	10	117
5970	-4.5	50	10	197
6096	-5.2	49.2	10	92
6571	-8.1	46.3	12	84
7620	-16.3	40	14	87
9144	-26.2	32.8	12	132

Figure 19: Meteorology of the FJSIM model on August 1, 2001



Height (MSL)	Temperature	Barometric Pressure	Wind Speed	Wind Direction
m	deg C	kPa	kts	deg
357	1	98.6	4	182



Height (MSL)	Temperature	Barometric Pressure	Wind Speed	Wind Direction
m	deg C	kPa	kts	deg
357	1	98.6	4	182
914	8.5	92.1	16	217
1219	7.5	88.7	14	237
1829	6.7	82.4	6	287
2438	4.5	76.4	10	137
2743	4.1	73.6	17	122
3658	-1.5	65.6	17	97
4267	-6.2	60.7	16	77
5780	-17.9	50	17	42
7620	-32.2	38.7	16	47

Meteorology of FJSIM model for December 15, 1998

Figure 20 (a): Using only surface level meteorological data

Figure 20 (b): With meteorology defined at 10 altitude levels

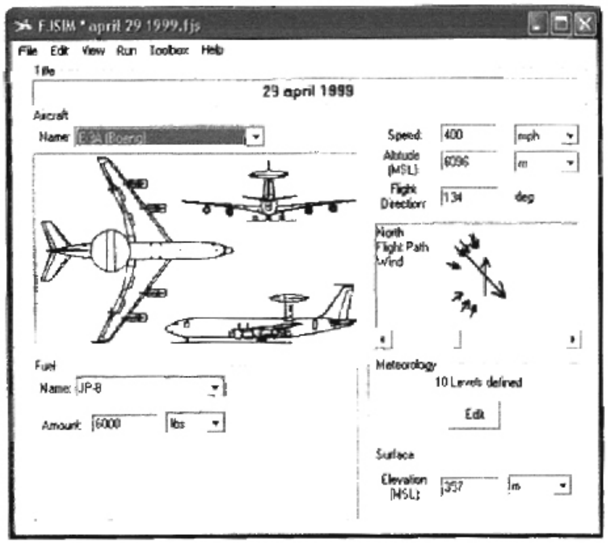


Figure 21 (a): Input values for E-3A on April 29, 1999

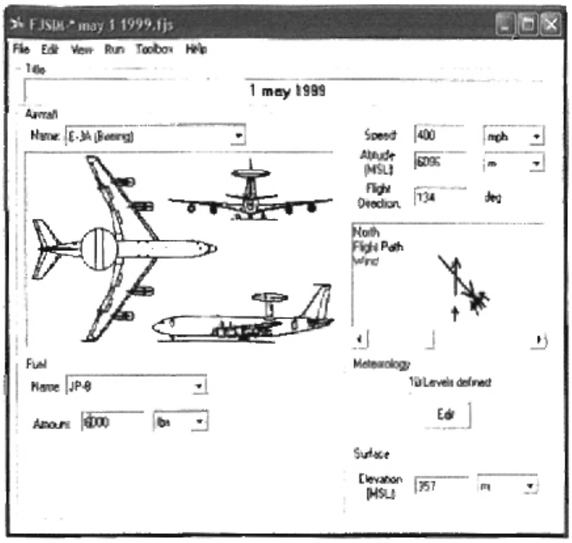
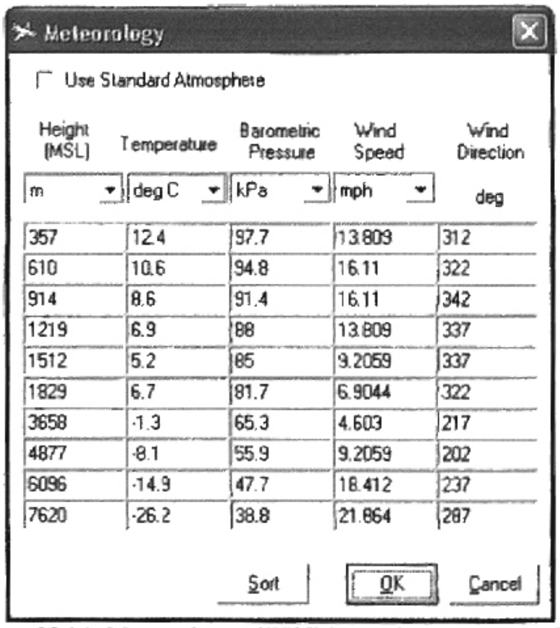


Figure 21 (b): Input values for E-3A on may 1, 1999

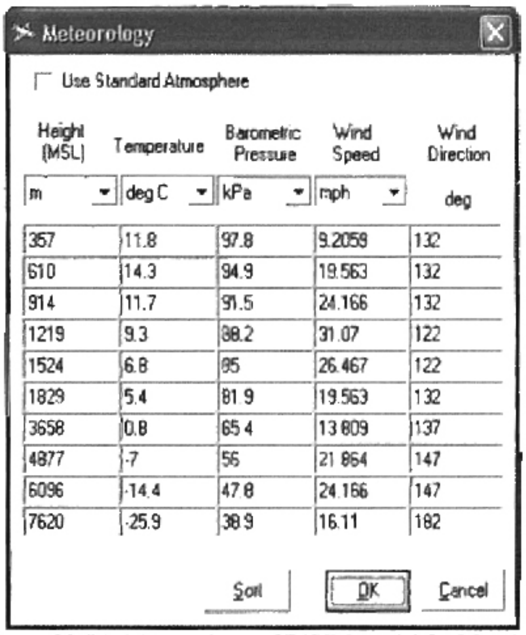

Meteorology

Use Standard Atmosphere

Height (MSL)	Temperature	Barometric Pressure	Wind Speed	Wind Direction
m	deg C	kPa	mph	deg
357	12.4	97.7	13.809	312
610	10.6	94.8	16.11	322
914	8.6	91.4	16.11	342
1219	6.9	88	13.809	337
1512	5.2	85	9.2059	337
1829	6.7	81.7	6.9044	322
3658	-1.3	65.3	4.603	217
4877	-8.1	55.9	9.2059	202
6096	-14.9	47.7	18.412	237
7620	-26.2	38.8	21.864	287

Sort OK Cancel

Figure 22 (a): Meteorology of FJSIM model for April 29, 1999


Meteorology

Use Standard Atmosphere

Height (MSL)	Temperature	Barometric Pressure	Wind Speed	Wind Direction
m	deg C	kPa	mph	deg
357	11.8	97.8	9.2059	132
610	14.3	94.9	19.563	132
914	11.7	91.5	24.166	132
1219	9.3	88.2	31.07	122
1524	6.8	85	26.467	122
1829	5.4	81.9	19.563	132
3658	0.8	65.4	13.809	137
4877	-7	56	21.864	147
6096	-14.4	47.8	24.166	147
7620	-25.9	38.9	16.11	182

Sort OK Cancel

Figure 22 (b): Meteorology of FJSIM model for May 1, 1999

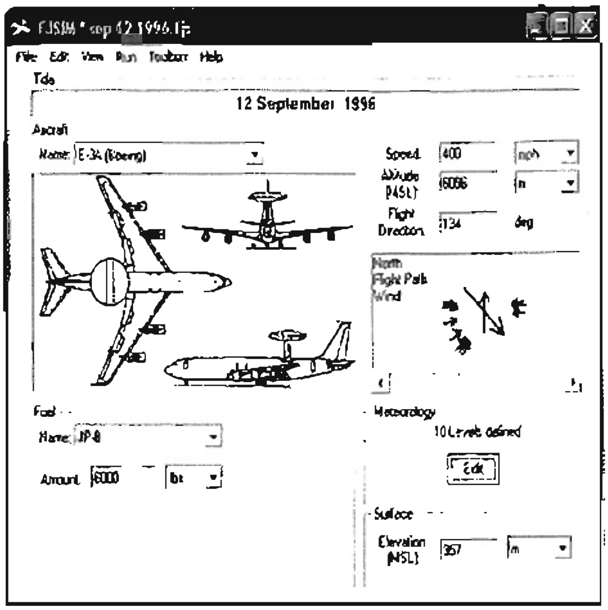


Figure 23: Input parameters on September 12, 1996

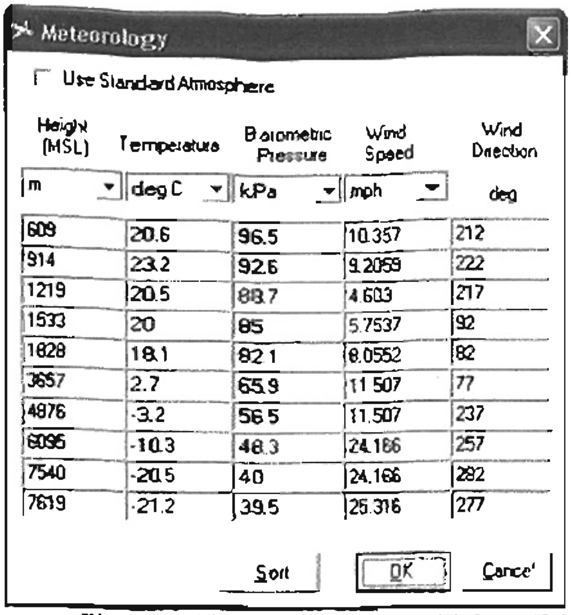


Figure 24(a): Meteorology on 12 Sept, '96

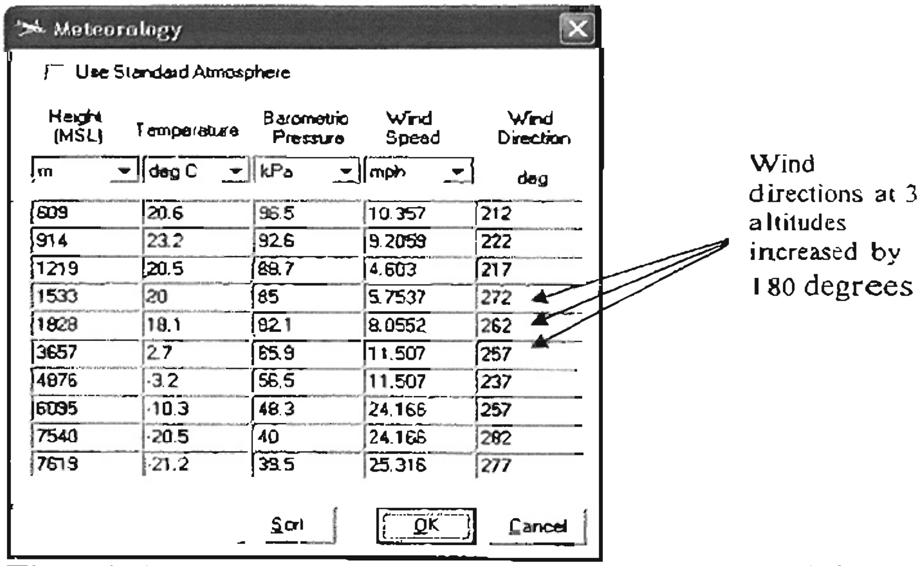


Figure 24(b): Wind directions at 3 altitudes increased by 180 degrees

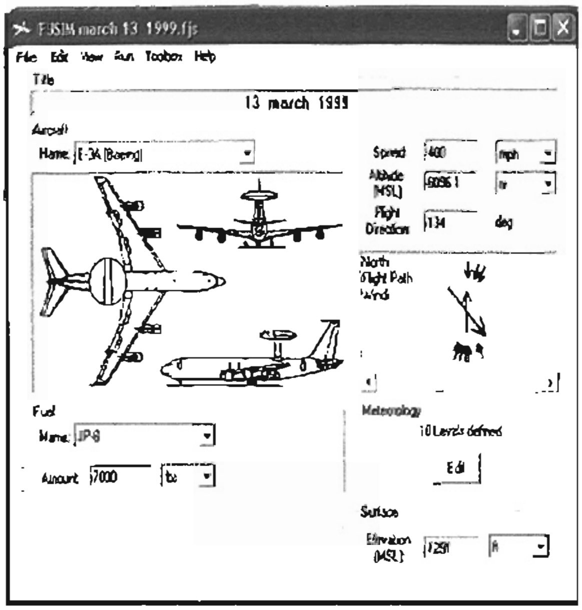


Figure 25 (a): Wind direction from N-S

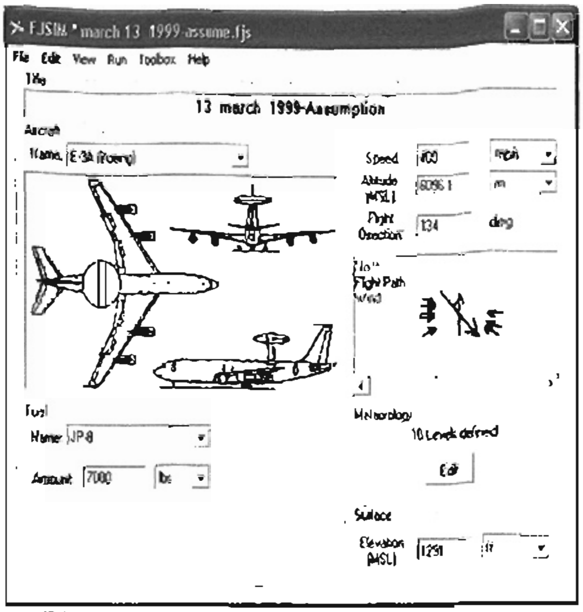
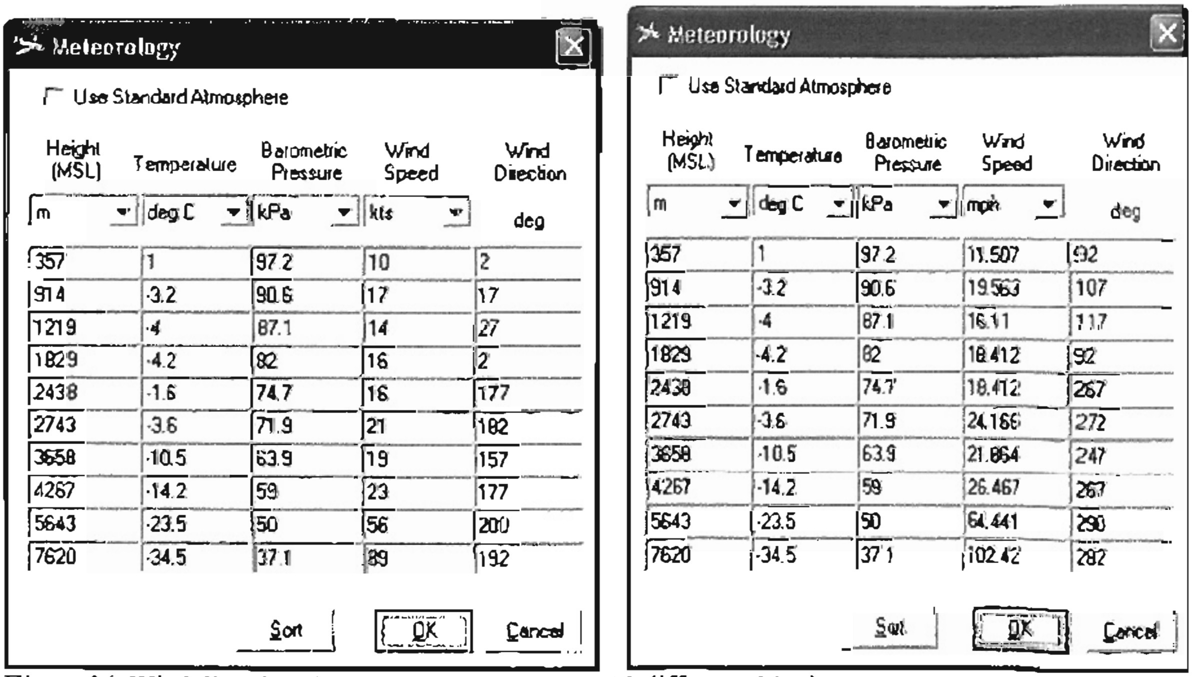


Figure 25(b): Wind direction from E-W



Meteorology

Use Standard Atmosphere

Height (MSL) m	Temperature deg C	Barometric Pressure kPa	Wind Speed kts	Wind Direction deg
357	1	97.2	10	2
914	-3.2	90.6	17	17
1219	-4	87.1	14	27
1829	-4.2	82	16	2
2438	-1.6	74.7	16	177
2743	-3.6	71.9	21	182
3658	-10.5	63.9	19	157
4267	-14.2	59	23	177
5643	-23.5	50	56	200
7620	-34.5	37.1	89	192

Sort OK Cancel

Meteorology

Use Standard Atmosphere

Height (MSL) m	Temperature deg C	Barometric Pressure kPa	Wind Speed mph	Wind Direction deg
357	1	97.2	11.507	92
914	-3.2	90.6	19.563	107
1219	-4	87.1	16.11	117
1829	-4.2	82	18.412	92
2438	-1.6	74.7	18.412	267
2743	-3.6	71.9	24.166	272
3658	-10.5	63.9	21.864	247
4267	-14.2	59	26.467	267
5643	-23.5	50	64.441	290
7620	-34.5	37.1	102.42	282

Sort OK Cancel

Figure 26: Wind directions increased by 90 degrees at 10 different altitudes

VITA

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